

N O T I C E

THIS DOCUMENT HAS BEEN REPRODUCED FROM
MICROFICHE. ALTHOUGH IT IS RECOGNIZED THAT
CERTAIN PORTIONS ARE ILLEGIBLE, IT IS BEING RELEASED
IN THE INTEREST OF MAKING AVAILABLE AS MUCH
INFORMATION AS POSSIBLE

Remote Sensing Research and Applications in Oregon

R.I. = 100.18
CR- 163533

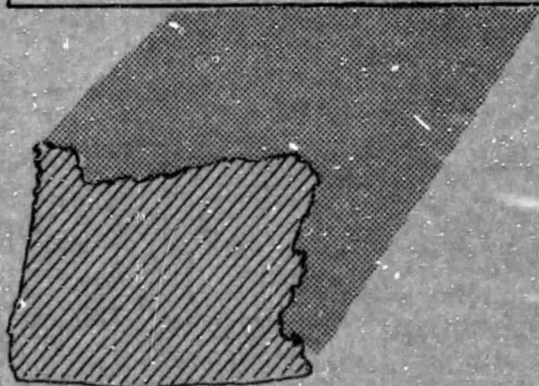
"Made available by the NASA sponsorship
in the Environmental Remote Sensing
Applications Laboratory (ERSAL) for dis-
semination of research & survey
information. No warranty is made
for any use of the information."

EIGHTH YEAR PROJECTS AND ACTIVITIES OF THE ENVIRONMENTAL REMOTE SENSING APPLICATIONS LABORATORY (ERSAL)

by

Anthony J. Lewis, Dennis L. Isaacson &

Barry J. Schrumpt



OREGON
STATE
UNIVERSITY

COORDINATED BY THE
ENVIRONMENTAL REMOTE
SENSING APPLICATIONS
LABORATORY.

(E81-10013) EIGHTH YEAR PROJECTS AND
ACTIVITIES OF THE ENVIRONMENTAL REMOTE
SENSING APPLICATIONS LABORATORY (ERSAL)
Annual Progress Report, 1 Apr. 1979 - 31
Mar. 1980 (Oregon State Univ.) 93 p

N81-12490

Unclass
33/43 00013

Environmental Remote Sensing Applications Laboratory
Oregon State University
Corvallis, Oregon
97331

8.1-100.18
CR-143533

EIGHTH YEAR PROJECTS AND ACTIVITIES
OF THE
ENVIRONMENTAL REMOTE SENSING APPLICATIONS LABORATORY
(ERSAL)

by

Anthony J. Lewis, Dennis L. Isaacson, and Barry J. Schrupf

ANNUAL PROGRESS REPORT TO:

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
OFFICE OF UNIVERSITY AFFAIRS
WASHINGTON, D.C. 20546

For the Period
1 April 1979 through 31 March 1980
Under NASA Contract No. NGL 38-002-053

In cooperation with State, County, and Municipal Governments, with
Councils of Government, and with Federal Agencies in the State of
Oregon.

ORIGINAL CONTAINS

ILLUSTRATIONS

Aerial photography may be purchased from
EROS Data Center

Sioux Falls, SD

TABLE OF CONTENTS

Acknowledgements	1
A Note of Acknowledgement, Appreciation and Affection	ii
Summary	1
ERSAL Projects for the NASA Office of University Affairs . .	2
Cooperative Projects Funded by Agencies other than NASA. . .	3
I. The ERSAL Program	4
Introduction	4
Organization	4
Facilities and Personnel	5
Lab Visitors	7
Involvement with Oregon Agencies and Organizations	10
Newsletter Publication	20
Project Initiation and Operation	24
II. ERSAL Projects.	25
A. Completed Projects for the NASA Office of University Affairs	25
Application of Remote Sensing Data in Support of Rehabilitation of Wild-Fire Damaged Areas . . .	26
Landsat 3 RBV: Forestry Mapping Applications. . .	29
B. Continuing Projects for the NASA Office of University Affairs	34
Western Oregon Timber Clearcut Monitoring Project. .	35
Wheat Disease Detection and Monitoring	46
Land Use Monitoring Projects for Tax Assessment- Umatilla, Lake, and Morrow County Assessors' Offices	49
Application Projects Using Oregon Air National Guard Thermal Infrared Scanning Data	52
C. ERSAL Projects Funded Through Outside Agency Support. .	54
Remote Sensing Inventory of Elk in the Blue Mountains.	55

Estimation of Burned Agricultural Acreage in the Willamette Valley.	58
Natural Resource Inventory of Deschutes County .	61
Landsat Digital Workshop	62
Summary of Projects Funded by Sources Other Than NASA Office of University Affairs	63
D. Future Projects	67
Appendix - ERSAL Employee Resumes	71
Alexander, Cassandra J.	72
Hall, Madeline J.	73
Isaacson, Dennis L.	74
Lewis, Anthony J.	76
Murray, RJay	83
Schrumpf, Barry J.	84
Smith, H. Gregory.	86

ACKNOWLEDGEMENTS

The work reported in this document is the result of contributions by many people at the Environmental Remote Sensing Applications Laboratory and various state and county agencies, as well as NASA and other federal agencies. ERSAL personnel who have contributed to this report include the following:

C.J. Alexander	J.D. Montague
M.C. Carrick	R. Murray
R.D. Crenshaw	D.S. Parker
N. DeSautel-True	S.A. Ruotsi
R.J. Fleury	H.G. Smith
M.J. Hall	J.R. Smith
D.L. Isaacson	R.L. Watkins
C.A. Lang	K.R. Yates
A.J. Lewis	J.A. Youngberg

B.J. Schrumpf, Director
Environmental Remote Sensing Applications Laboratory

Contributions have also been made by:

Donavin Leckenby
Oregon Department of Fish and Wildlife

George Shore, Mapping Director
Oregon Department of Forestry

A NOTE OF ACKNOWLEDGEMENT, APPRECIATION AND AFFECTION

During this past year we lost a good friend and colleague, J. Ralph Shay. Beginning in the early 1960's Ralph encouraged, created and fought for opportunities to bring the emerging technology of remote sensing to bear on agricultural and natural resource problems. He held a clear view of the future and worked with constant perseverance to bring people and programs together for a common good. Since ERSAL was established in 1972 he served as an advisor, providing both ideas and guidance. Ralph was always enthusiastic and optimistic. His involvement was appreciated and his ideas respected. The memory of his daily example is a cherished lesson.

SUMMARY

The purpose of ERSAL is to work in cooperation with the public agencies in Oregon to develop applications utilizing remote sensing technology so decisions can be made and acted upon directly by those agencies, resulting in regulatory activity or on-the-ground activity. ERSAL helps familiarize public agency personnel with this technology so they may more effectively utilize it for ground-based decision-making now and in the future.

The long-term objectives of ERSAL are to:

1. Extend remote sensing applications information, and technology to new potential users and beneficiaries for use as a key decision-making tool.
2. Use remote sensing technology to solve practical problems in:
 - a. resource management
 - b. resource allocation
 - c. urban development
 - d. agricultural practices
3. Maintain a center and browse file of NASA imagery in Oregon.
4. Provide consultation and instruction to those seeking advice on image analysis and remote sensing.
5. Identify and investigate research needs that are oriented to remote sensing applications.
6. Help coordinate remote sensing activities and projects among local, state, and federal agencies within the State of Oregon.

ERSAL has continued to orient its project development and application work toward those projects that result in applications and decisions made directly by the user agency in a relatively short period of time. ERSAL is maintaining a working relationship with those state and federal agencies in Oregon having strong regulatory functions and extensive resource management functions. ERSAL is also developing a working relationship with the new personnel in the above agencies as administrations change and personnel transfer within these agencies.

Project development work with these agencies has been and is being conducted to identify those projects where decisions can be derived using remote sensing technology and determining those agencies that can implement directly upon those decisions.

The following are the more significant accomplishments during the reporting period:

ERSAL Projects for the NASA Office of University Affairs

1. Forest Fire Rehabilitation -- Forest fires can cause both immediate and long term losses. Not only are timber, wildlife, wildlife habitat, watershed and recreational facilities immediately lost but unprotected soils on steep slopes present an immediate threat through erosion to downstream water quality and fisheries. The on site loss of soil also diminishes the vegetation production capacity of the land and greatly delays the return of the site attributes that were present prior to the burn. There are immediate protective measures that can be taken that will reduce the long term impacts - but action must be swift and well directed. ERSAL staff worked with U.S. Forest Service personnel to develop rehabilitation plans which were then utilized in guiding rehabilitation efforts on a 1979 fire. Combinations of computer processed Landsat data and aerial photography provided valuable management information for the decision making and subsequent actions.
2. Map Updating with Landsat 3 RBV Images -- Cost of updating existing maps has slowed production efforts to a rate that causes many Fire District Maps to be several years out of date. Landsat 3 RBV images are economical, easy to handle, image large areas and contain sufficient detail to permit the rapid updating of existing maps. The Oregon State Forestry Mapping Director has been testing several ways of capitalizing on the attributes of RBV imagery and for incorporating RBV imagery into his agency's mapping program.
3. Timber Clearcut Monitoring -- The Timber Assessment Division of the Oregon Department of Revenue is developing methods for gathering information on timber harvesting for taxation purposes. Monitoring timber brought to mills is the primary procedure, however this overlooks violators. ERSAL staff are working with Timber Assessment personnel to evaluate remote sensing techniques for detecting apparent violations. Landsat MSS image interpretation did not prove dependable. However, high levels of accuracy (> 90%) and sensitivity to change of areas smaller than five acres detected from Landsat 3 RBV images has been very encouraging. Technique development and testing with this data base is proceeding.
4. Wheat Disease Detection -- Wheat is the largest income producing crop in Oregon. In irrigated fields of north central Oregon the

foot rot disease known as "take all" drastically reduces head filling with a resultant substantial decrease in yield. The financial loss can be partially reduced by harvesting the wheat for hay. Frequent monitoring with color infrared photography provides an effective and economical way for the farm manager to assess the magnitude of the "take all" infestation on a field by field basis.

Cooperative Projects Funded by Agencies other than NASA

1. Northeastern Oregon Elk -- Computer assisted analysis of Landsat data is being employed to map and evaluate habitat in two elk ranges in the Blue Mountains of northeastern Oregon. Areas that provide forage, thermal cover or hiding cover are mapped and proportions of each component are computed for portions of the range. The information is needed for planning timber management practices that will produce results that are also compatible with elk habitat requirements. The Oregon Department of Fish and Wildlife plans to continue this approach of inventory on elk, deer and antelope ranges.
2. Deschutes County Land Use Planning -- The County Planning Office has contracted with ERSAL to prepare maps of land cover for the entire county excluding current urban areas. Landsat MSS digital data is being utilized to prepare a data base current to 1978. The county has committed a full time staff member to the project to help insure the appropriate development of products and to plan and execute the incorporation of the Landsat derived products into the county planning process.
3. Grass Seed Field Burning -- ERSAL staff were contracted by the Oregon Department of Environmental Quality to prepare an estimate of burned acres in the Willamette Valley for the years 1975-1979. Two 1979 estimates were based on sample of visual observations and interpreted Landsat MSS prints. Estimates for earlier years were developed from interpretations of Landsat MSS prints. Estimates with confidence intervals showed evidence of under-reporting by farmers; the DEQ therefore does not fully realize revenues from permits. The successful results caused DEQ to engage ERSAL services for the 1980 burning season and has made improvements in procedures as recommended by ERSAL.

I. THE ERSAL PROGRAM

INTRODUCTION

The Environmental Remote Sensing Applications Laboratory has been acquainting federal, state, county, and local agencies with remote sensing technology and its applications since 1972. Since that time, the personnel of ERSAL have been conducting applications projects with many of these agencies demonstrating the utility and effectiveness of remote sensing to provide the information necessary to make decisions. ERSAL is now orienting its applications project development with those agencies that can make decisions within their own agency and bring about on-the-ground effects due to remote sensing input.

ERSAL has conducted application projects that have involved many disciplines with the primary emphasis on management of natural resources. The personnel of ERSAL have also discussed the various aspects of remote sensing and its application with agencies, groups, and private individuals so they can become more knowledgeable about remote sensing and help in the development of new applications. This report deals primarily with the projects and activities that have taken place at the Environmental Remote Sensing Applications Laboratory during the period 1 April 1979 through 31 March 1980.

ORGANIZATION

The Environmental Remote Sensing Applications Laboratory is organized as a unit under the office of the Dean of Research giving ERSAL the status of a university-wide laboratory. The organizational plan of ERSAL allows much interaction of its personnel with Oregon State University faculty members from many disciplines. This input has provided many ideas for applications work or improvement of techniques currently used.

FACILITIES AND PERSONNEL

The physical facilities from which the ERSAL staff operate are: a main work room, a computer analysis and office room, a photographic copying room and darkroom, and a main office including the Director's office, the reference library and secretarial-administrative office space.

The main workroom of the Laboratory is equipped with large tables and light tables which provide centralized work surfaces. The main workroom and a drafting table in the reference library are equipped with cartographic equipment so mapping and cartographic work can be carried out. The main workroom houses the film library which consists of all the NASA-flown aerial photography over Oregon, and files of Landsat imagery (both 70mm and 9"x9" four-band positive transparencies).

Eight map cases in the main workroom hold imagery enlargements, photomosaics, and topographic and planimetric maps used for general reference and project preparation. They also hold project results such as Landsat computer maps, NASA U-2 photointerpretation maps, and associated project results which are used for reference and demonstration to user agencies as examples of remote sensing utilization. A large copy storeroom off the main laboratory provides for additional map and project materials storage with easy accessibility.

Image viewing and analysis is facilitated by several stereoscopes, including three Old Delft stereoscopic scanners and a Bausch and Lomb zoom transfer scope. ERSAL has acquired two Federal surplus photointerpreter units which have the capacity for viewing aerial roll film stereoscopically. These units provide additional training and analysis space for user agency personnel when they are conducting projects with ERSAL.

The computer analysis and office room has a magnetic tape drive and a paper tape reader interacting with the Varian 71 minicomputer, Hazeltine 200C visual

display terminal and Statos electrostatic printer/plotter at our facility. This combination of equipment has greatly improved the quality and increased the variety of output products which can be developed by computer mapping from Landsat data. This equipment has enabled ERSAL to produce computer maps that closely approximate conventional maps. This approach results in better utilization of the maps by the user agencies. The equipment has also provided ERSAL with the capability of producing accurate computer maps at reduced expense which makes utilization of Landsat digital data more practical from the user's standpoint.

The Laboratory is directly linked with the CDC 3300 and the CDC CYBER-73 computers at the Oregon State University Computer Center. ERSAL has ready access to the available digital processing programs and the two computers through the ERSAL display terminal or through an adjoining computer remote terminal room. The Laboratory's direct link with the computers and computer programs provide interactive processing of Landsat digital data using either ERSAL's printer/plotter or the Computer Center's line printers.

A photographic darkroom is available for experimental testing of photographic techniques and for limited production work. The photographic copying room houses a Polaroid MP-3 copy camera for film copying and a GE Ozamatic Ozalid machine which is used to make inexpensive, high-quality color composites of Landsat imagery.

Part of the browse file service to visitors in the file is microfilm Landsat imagery for both U.S. and non U.S. coverage. A microfilm reader is available in the office library along with the Landsat reference catalogs. A growing collection of NASA reprints on microfiche is also available for visitor use.

Dr. Anthony J. Lewis, a physical geographer having specialized in interpretation of microwave imagery, fluvial geomorphology and aerial photo interpretation, joined the ERSAL staff as a full time Research Associate. His principle responsibility is on the NASA grant. He has readily established contacts in several state agencies, and among several roles now serves as a consultant to agencies on uses of radar imagery. Dr. Gary Benson has left the ERSAL staff to join the U.S. Forest Service in California. H. Gregory Smith has joined the staff as a Graduate Research Assistant. He assists in the design and conduct of several digital processing projects.

Dr. Barry Schrumpf is the ERSAL Director. The following resource analysts, Cassandra Alexander, Madeline Hall, Dennis Isaacson, and RJay Murray assist visitors and coordinate project initiation and development.

The support staff at ERSAL includes a secretary, a clerk-typist, and technicians skilled in areas such as manual imagery interpretation, computer programming, graphic arts, and photographic and ozalid operations.

Resumes of ERSAL staff are included in the Appendix.

LAB VISITORS

During the reporting period, ERSAL has carried out an analysis of usage and visitation of our facility. Visitors to the lab were requested to voluntarily enter their names and affiliation into a guest book. Since not all visitors remembered, or declined to register, the analysis represents only a portion of the Lab's visitation. The analysis is presented in Table 1.

Since its beginning, ERSAL has been visited by many staff members from various county, regional, state and federal agencies. They have become acquainted with the remote sensing materials we possess and our

Table 1.

Analysis of visitors to the Environmental Remote Sensing Applications Laboratory, 1 April 1979 through 31 March 1980*.

Disciplines	University	City or County	State	Federal	Private	TOTAL
Agriculture and Soils	8	1	2	1		12
Botany	3					3
Environment/Conservation	2	4	7	2		15
Engineering and Power	5		4			9
Fisheries and Wildlife	3	1	7	7		18
Forestry and Range	7	1	5	21	3	37
Geology and Hydrology	3	1				4
Parks and Recreations			3	2		5
Planning		2	2		1	5
Remote Sensing Applications	1		1	11	1	14
Water Resources	2	1	3	2		8
Biology	6					6
Oceanography	2					2
Landscape Architecture					4	4
Cultural Resources	3	1				4
Revenue	1		1			2
Other	22	2	2		21	47
Geography	63		1	3	2	69
TOTAL	131	13	39	49	32	264

* Based upon voluntary registration in guest book.

capabilities which include being able to provide information about current remote sensing data availability and remote sensing applications activities occurring within the State. The remote sensing data information provided can include conventional aerial photography, NASA U-2 photography, satellite data and other types of remote sensing imagery such as thermal infrared scanning and side looking radar imagery.

After becoming knowledgeable of ERSAL's capabilities and its staff proficiency, these agency personnel now telephone in their information requests rather than visit ERSAL personally. These telephone requests number a few hundred each year. As a consequence, these requests represent a large portion of Oregon agency usage of ERSAL's service that should be noted along with the visitation totals.

INVOLVEMENT WITH OREGON AGENCIES AND ORGANIZATIONS

The form of involvements that ERSAL has with Oregon agencies and organizations varies considerably from one group to another and extends from providing short responses to single inquiries to engaging in long term, complex projects. The following summary provides some insight into the forms of involvement that have developed with specific agencies. Minor assistance usually involves providing help with imagery, explanation of remote sensing techniques and satellite systems, or direction regarding where to turn for additional help other than that which ERSAL can provide. A significant contact goes beyond minor assistance and usually involves initial levels of training, some use of ERSAL facilities (1 day to 2 weeks), and use of imagery by the visitor to gather information for some specific purpose. A cooperative project involves work with the agency to identify a resource management/regulatory problem that will meet the criteria for project assistance from ERSAL and then to conduct the project. These levels of involvement have caused some agencies to provide funding from their own budgets for conducting remote sensing projects. In some cases ERSAL has served as the contractor. A summary table of contracted projects supported by sources other than the NASA University Program is presented later in this report in the section titled "ERSAL Projects Funded through Outside Agency Support".

Agencies/organizations in Oregon with whom ERSAL has had or provided:

	Cooperative Projects	Significant Contact	Minor Assistance
<u>Federal</u>			
Dept. of Agriculture			
Agricultural Stabilization & Conservation Service			X
Forest Service			
Region 6 Headquarters	X	X	X
State & Private Forestry	X		

<u>Federal, cont'd.</u>	Cooperative Projects	Significant Contact	Minor Assistance
Fremont National Forest			X
Malheur " "		X	X
Mount Hood " "		X	X
Ochoco " "	X		
Siskiyou " "			X
Umpqua " "	X		X
Willamette " "			X
Winema " "			X
Pacific Northwest Forest and Range Experiment Station			
Wildlife Habitat Lab			X
Forest Sciences Lab		X	X
Soil Conservation Service	X		X
Dept. of Army			
Corps of Engineers	X	X	X
Dept. of Commerce			
National Oceanic & Atmospheric Administration			
National Marine Fisheries Service			X
Dept. of Energy			
Bonneville Power Administration	X	X	X
Environmental Protection Agency			
Corvallis Environmental Research Lab		X	X
Dept. of Interior			
Fish & Wildlife Service			
Biological Services			X
Ecological Services	X		X
Finley Wildlife Refuge			X
Sheldon-Hart Mountain Wildlife Refuge			X

	Cooperative Projects	Significant Contact	Minor Assistance
<u>Federal cont'd.</u>			
Geological Survey			
Water Resources Division	X		X
Bureau of Indian Affairs			X
Bureau of Land Management			X
Bureau of Mines			X
National Park Service		X	X
Bureau of Reclamation		X	
Pacific Northwest River Basins Commission		X	X
<u>Interstate/regional</u>			
Columbia Region Council of Governments			X
Pacific Northwest Regional Commission		X	X
<u>State</u>			
Dept. of Agriculture	X	X	X
" " Energy			X
" " Environmental Quality	X	X	X
" " Fish & Wildlife	X	X	X
" " Forestry	X	X	X
" " Geology & Mineral Industries		X	X
" " Land Conservation & Development		X	X
" " Revenue	X	X	X
" " Transportation			
Environmental Section	X	X	X
Highway Division	X	X	X
State Parks		X	X
Dept. of Water Resources	X	X	X
Dept. of State Police			X

	Cooperative Projects	Significant Contact	Minor Assistance
<u>State, cont'd.</u>			
Division of State Lands			X
" " Emergency Services			X
" " State Health			X
Executive Department			
Budget Division		X	
Natural Resources Assistant			X
Coastal Conservation & Development Comm.		X	X
Military Department			X
Natural Area Preserves Advisory Committee	X	X	X
Soil & Water Conservation Commission			X
State Fair		X	
<u>Intercounty</u>			
Mid-Willamette Council of Governments		X	X
Umpqua Regional " " "			X
Lane " " "			X
Benton-Linn Counties Council of Gov.			X
Central Oregon " "	X		
<u>Counties</u>			
Baker Co. Extension Office			X
Benton Co. Assessor's Office			X
Health Dept.			X
Mountain Rescue			X
Planning Dept.	X		
Vector Control			X
Clackamas Co. Dept. of Public Works		X	X
Clatsop Co. Planning Dept.			X
Clatsop Plains Study Task Force	X		

<u>Counties, cont'd.</u>	Cooperative Projects	Significant Contact	Minor Assistance
Coos Co. Planning Dept.			X
Crook Co. Planning Dept.	X	X	X
Curry Co. Assessor's Office			X
Deschutes Co. Assessor's Office	X		X
Deschutes Co. Planning Office	X		
Douglas Co. Engineer's Office			X
Soil Scientist			X
Gilliam Co. Assessor's Office			X
Grant Co. Extension Office		X	X
Natural Resource Council		X	
Hood River Co. Forest Dept.			X
Jackson Co. Extension Office		X	
Jefferson Co. Planning Dept.	X		
Josephine Co. Assessor's Office			X
Extension Office			X
Klamath Co. Assessor's Office			X
Planning Dept.		X	
Lake Co. Assessor's Office	X		
Planning Commission	X		
Lane Co. Environmental Health Dept.			X
Vector Control			X
Water Pollution Control			X
Lincoln Co. Planning Dept.		X	X
Linn Co. Planning Dept.		X	X
Morrow Co. Assessor's Office	X		
Polk Co. Assessor's Office			X
Planning Dept.			X
Tillamook Co. Extension Office			X

	Cooperative Projects	Significant Contact	Minor Assistance
<u>Counties, cont'd.</u>			
Umatilla Co. Assessor's Office	X		X
Planning Dept.			X
Wasco Co. Assessor's Office			X
Washington Co. Assessor's Office			X
Planning Dept.	X		
Yamhill Co. " "			X
<u>Cities</u>			
Corvallis Fire Dept.			X
Eugene Water & Electric Board			X
Lincoln City Planning Dept.			X
Portland Planning Dept.	X		
<u>Educational</u>			
Oregon State University, incl.:		X	X
Agricultural Experiment Station			
Air Resources Center, Agronomic			
Crop Science, Agricultural			
Chemistry, Agric. & Resource			
Economics, Agric. Engineering			
Technology, Anthropology,			
Atmospheric Sciences,			
Biochemistry/Biophysics,			
Botany & Plant Pathology,			
Business, Civil Engineering,			
Computer Center, Cooperative			
Wildlife Research Unit, Dean of			
Research, Economics, Electrical			
& Computer Engineering, Fish &			
Wildlife, Forest Management,			

	Cooperative Projects	Significant Contact	Minor Assistance
<u>Educational, cont'd.</u>			
Oregon State University, cont'd.			
Forest Research Lab, Geography, Geology, Herbarium, Landscape Architecture, Library, Microbiology, Oceanography, Rangeland Resources, Recreational Resource Management, Science Education, Seed Certification, Soil Science, Statistics, Water Resources Research Institute, Zoology			
University of Oregon		X	X
Portland State University			X
Oregon College of Education			X
Oregon Institute of Technology			X
Southern Oregon State College		X	X
Central Oregon Community College			X
Clatsop Community College			X
Linn-Benton " "			X
Southwest Oregon Community College			X
Treasure Valley " "		X	X
Umpqua " "			X
<u>Private</u>			
Albany Democrat-Herald		X	
Bohemea Realty			X
Boise Cascade Corp.	X		
Brooks-Scanlon			X
CH ₂ M-Hill			X

<u>Private cont'd.</u>	Cooperative Projects	Significant Contact	Minor Assistance
Consumers Power, Inc.			X
Corvallis Gazette Times		X	
Crop Protection, Inc.		X	
Dick White - Consulting Geologist			X
Foundation Sciences, Inc.			X
Hewlett Packard Corp.			X
Insight Reconnaissance			X
John Hook - Consulting Geologist		X	X
Larry Wilkinson - Consulting Engineer			X
Montagne-Bierly Assoc.		X	X
Moreland, Unruh, & Smith			X
Nature Conservancy		X	X
Oregon Archaeological Society			X
Oregon Farmer-Stockman		X	X
Oregon Natural Heritage Program		X	X
Pacific Northwest Bell			X
Portland Power & Light Co.		X	X
Professional Timber Management			X
Seton, Johnson, & Odell, Inc.			X
Spectrum Color Lab			X
The Oregonian		X	
Western Ways		X	X
Wilsey & Ham Consultants			X
Woodward-Envicon Portland			X
ZX Ranch		X	

In many instances, although "significant contact" has been made, visiting agencies have application projects that ERSAL cannot become involved in due to some or all of the following:

- 1) The project would use remote sensing as only one among many sources of information.
- 2) The project does not have high potential of an operational decision forthcoming in a short time frame following project completion.
- 3) Implementation of project information cannot be made directly by that agency.

In such cases as these, ERSAL invites the agency to utilize the ERSAL facility with the agency personnel carrying out the work in the lab. This arrangement can be carried out as long as the visiting agency does not interfere with any of the on-going ERSAL project work.

Research personnel from the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, the U.S. Forest Service and the OSU Department of Atmospheric Sciences each spent at least one man-week at the ERSAL facility. Most of the visiting personnel from the above agencies utilized U-2 high altitude aerial photography, light tables, photo copy equipment, and various photo interpretation equipment.

More specifically, personnel from the Corps of Engineers were identifying geological hazards (faults, fractures, erosion and seepage) related to dam structures. The Fish and Wildlife people were and are continuing to work on cover type analysis of three wildlife refuges in the central Willamette Valley. The identification of wetlands and critical game management vegetation types is a primary concern. Fish and Wildlife personnel have already scheduled for the use of the June, 1980 U-2 coverage of the Willamette Valley when the imagery arrives.

Forest and land cover types were mapped with the U-2 high altitude aerial photography by the U.S. Forest Service.

Personnel from the Department of Atmospheric Sciences utilized Landsat MSS imagery, U-2 aerial photography and airborne imaging radar of Oregon for the purpose of locating potential wind power generating sites in Oregon. Library research and conversations with ERSAL staff focused around the availability and feasibility of different types and scales of remotely sensed data for incorporation in this type of study.

NEWSLETTER PUBLICATION

A newsletter is prepared at ERSAL and distributed to organizations within Oregon. The content includes an explanation of the NASA supported program conducted at ERSAL, brief descriptions of completed applications projects, updates on remote sensing data gathering systems, and lists of important dates and happenings in remote sensing. The distribution list of over 800 addresses is quite comprehensive and includes:

- a) in each of Oregon's 36 counties
 - Cooperative Extension Service
 - County Tax Assessor
 - County Planning Office
 - County Parks and Recreation
 - County Soil Scientist
 - County Forester
- b) several divisions, sections, etc., of each of the following state agencies/organizations in offices throughout the state
 - Department of Agriculture
 - " " Energy
 - " " Environmental Quality
 - " " Fish and Wildlife
 - " " Forestry
 - " " Geology and Mineral Industries
 - " " Land Conservation and Development
 - " " Revenue
 - " " Transportation
 - " " Water Resources

- Division of State Lands
 - " " Emergency Services
 - " " Intergovernmental Relations
 - State of Oregon Military Department
 - Office of Intergovernmental and Public Affairs
 - Information and Program Analysis Section
 - State Health Planning and Development Agency
 - " Librarian
 - " Soil and Water Conservation Commission
 - " Tax Commission
 - Port of Portland Commission
 - Pacific Marine Fisheries Commission
 - Columbia River Gorge Commission
 - Oregon Nuclear and Thermal Energy Council
 - " Environmental Council
 - " State Marine Board
 - Board of Geologists
 - Columbia Region Association of Governments
 - Mapping Committee on Natural Resources
- c) several divisions, etc., of federal agencies in offices throughout the state
- Agricultural Marketing Service
 - " Research Service
 - " Stabilization and Conservation Service
 - Army Corps of Engineers
 - Bureau of Indian Affairs

- Bureau of Land Management
 - " " Mines
 - " " Reclamation
 - Environmental Protection Agency
 - Federal Highway Administration, Region 10
 - Fish and Wildlife Service
 - Forest Service
 - Region 6 Headquarters
 - National Forests Headquarters
 - Ranger Districts
 - Pacific Northwest Forest and Range Experiment Station
 - Geological Survey
 - National Marine Fisheries Service
 - " Park Service
 - " Recreational Areas
 - Soil Conservation Service
- d) state and federal government
- Governor
 - Executive Department
 - Several state legislators
 - Legislative Administration Committee
 - " Research
 - " Committee on Trade
 - Secretary of State
 - Governor's Assistant for Natural Resources
 - Oregon's Congressional Delegation to the U.S. Congress

e) additional recipients

- Individuals teaching remote sensing/photointerpretation/photogrammetry throughout Oregon
- Oregon Museum of Science and Industry
- State Councils of Governments
- State Economic Districts
- Oregon Agricultural Experiment Stations
- Commodity Commissions
- Pacific Northwest River Basins Commission
- Earth Resources Synthetic Aperture Radar Committees
- NASA centers
- EROS Data Center
- Technology Transfer Task Force
- Foreign Consuls in Portland

PROJECT INITIATION AND OPERATION

ERSAL has established and maintained effective communication with federal, state, and local agencies in the State of Oregon. Contact is maintained by meetings at their offices, at the Lab, or via phone conversations so continuity is maintained regarding projects they may have underway. During the last year, ERSAL has continued to make potential users aware of the current technology and practical applications of remote sensing. A concerted effort has been made to acquaint potential user agencies with the higher resolution return beam vidicon (RBV) imagery now available from Landsat 3, and explore application possibilities using this new information source.

ERSAL has developed applications projects by first acquainting the potential user agency with remote sensing and how it could be applied. Involvement in an applications project can only begin after considerable consultation between ERSAL staff and the user agency. ERSAL then proceeds with an applications project only if the user agency can demonstrate a direct application from the remote sensing input and the user agency has a strong potential to implement upon the application results.

Projects engaged in by the laboratory have to have a very high potential for direct application, and the agency must agree to several conditions prior to project initiation. Agreement must be reached regarding initiation and termination dates, scale of investigation, types of resources analyzed, what the product(s) will be used for, and how soon application results would be implemented. Following receipt of the product, agencies are expected to indicate the use(s) to which they were put.

In line with ERSAL's current attitude toward project development, ERSAL has elected to become involved only in projects where the user agency would utilize the remote sensing information directly and because of the agencies' capability to regulate or implement, reach a decision to bring about or cause to bring about on-the-ground activity or enforcement.

II. ERSAL PROJECTS

A. COMPLETED PROJECTS FOR THE NASA OFFICE OF UNIVERSITY AFFAIRS

The following are reports on projects that have been completed by ERSAL, primarily during the period between 1 April 1979 and 31 March 1980.

APPLICATION OF REMOTE SENSING DATA
IN SUPPORT OF
REHABILITATION OF WILD-FIRE DAMAGED AREAS*

On July 24, 1979 embers from a neglected campfire kindled a forest fire on the eastern slopes of Oregon's Cascade Range within the Deschutes National Forest. Prevailing westerly winds drove flames toward the central Oregon town of Bend and blackened a portion of the city's watershed. Local U.S. Forest Service officials, concerned about the extent and severity of damage to the area, developed a proposal for emergency rehabilitation designed to minimize post-fire losses to flooding and erosion. A funding commitment was received from USFS headquarters in Washington, D.C. before the fire was controlled on July 28.

The fire left a black scar seven miles long and one mile wide over steep terrain where highly erodible, pumice/ash-derived soils were left without protective vegetative cover. The USFS rehabilitation team was responsible for determining, and directing the immediate, practical, and effective action required to prevent expected losses from overland runoff when summer thunderstorms or seasonal fall rains occurred. Time for accomplishing this task was critically limited; no more than two months were available.

Such actions as seeding of grasses, construction of impoundments, contour terracing and salvage logging needed to be initiated as quickly as possible, but could only begin when sufficient information on the location, extent and nature of damage was available so that work crews could effectively be assigned specific tasks. Much of this information was acquired from aerial photography and from Landsat satellite data. Rapid analysis of

* This is a summary report of ERSAL Report 80-1.

these data sources, completed at the Environmental Remote Sensing Applications Laboratory (ERSAL), Oregon State University, provided information of sufficient detail and accuracy to support emergency rehabilitation actions.

Knowledge of the nature of vegetative cover prior to the burn helped USFS rehabilitation team members draw inferences about site capability. Distribution and density of indicator plants were studied on color infrared photography from NASA U-2 flights conducted in 1972 and 1978. Planning for quick protective cover compatible with longer-term management plans was thus possible. An example circumstance is illustrated by considering site capability where true firs (Abies spp.) were present before the fire. Presence of firs indicated good sites for regeneration with high productivity indices and relatively deep soils. Protection and reforestation of these sites with annual ryegrass provided an interim protective cover that would not be a serious competitor with newly planted trees. Tabulation of digital satellite data provided acreage totals for such sites so that the correct quantities of seed and fertilizer could be ordered and a seeding contract could be drafted.

Post-fire aerial photography provided information on burn intensity and on the condition of remaining vegetation. Salvageable standing dead trees were mapped. Infrared photography was studied to determine if recovery of scorched trees was likely, thereby identifying areas where natural regeneration would be expected. Debris likely to dam streams was located for removal.

Emergency treatment began after the fire was controlled, but before fire crews had been released. Planned work was completed on schedule. The total emergency treatment costs were about \$163,000 with acquisition and analysis of remotely sensed data being about \$5,000. Capital improvements

at risk totalled almost \$25 million and included the Bend municipal water system (\$7.5 million), irrigation water distribution systems (\$4.6 million) and 8,200 acres of intensively cultivated agricultural land (\$12.7 million). Intangible assets at risk included inherent site productivity, fish and wildlife habitats and recreational and scenic areas.

A thunderstorm of an intensity that would be expected once in every ten years occurred over the burn scar 83 days after the fire. Emergency treatments accomplished earlier were successful in averting any damage, and the only measureable effect was a slight increase in suspended ash noted at the Bend water system intake.

A similar thunderstorm over a burned area in Washington's Wenatchee National Forest in 1976 resulted in loss of 76% of capital improvements at risk and total estimated damage was more than \$18 million. No sophisticated methods or techniques were utilized in developing usable information from remotely sensed data in this application.

Benefits from use of remote sensing data demonstrably outweigh costs. Factors which limit the adoption of remotely sensed data in future projects include the requirement for near real-time access to such data and the limited knowledge of the existence of such data and techniques by rehabilitation team members.

Similar projects utilizing satellite and aircraft data are to be undertaken during the 1980 fire season.

LANDSAT 3 RBV: FORESTRY MAPPING APPLICATIONS ¹

To date, all of the satellites in the Landsat series have employed two imaging systems: return beam vidicon (RBV) and multispectral scanner (MSS). The RBV system, originally the prime data collection system, is a hybrid system with similarities of both the simple optical camera and a television camera. In an apparent attempt to utilize the inherent advantages of an RBV system and to reduce the amount of redundancy in spectral data between the MSS and RBV systems, Landsat 3 RBV was modified. The system changes of special importance to the users are 1) the elimination of one of the RBV cameras, 2) the almost doubling of the focal length of the two remaining RBV cameras, and 3) the more than two-fold increase in the spectral band-width of the RBV cameras 1 and 2. The combination of increased focal length and decreased exposure time has resulted in an increase in the ground resolution by a factor of approximately 2.6 or from a pixel size of 79 m by 79 m to around 30 m by 30 m. The value of the improved Landsat 3 RBV resolution goes beyond the increase in spatial detail. The image product is similar enough to an aerial photograph that the neophyte user of this high-level satellite technology is presented with a familiar format.

Landsat 3 RBV imagery helps many field people bridge the 570 mile gap from the ground to the satellite. It is a product to which field people can relate. Being panchromatic, the Landsat 3 RBV imagery can be introduced and used without dealing with the concept and values of the "multispectral approach". The camera-like RBV imaging system eliminates the necessity of introducing scanner technology.

¹ This is a summary report of ERSAL Report 80-2.

Since 1948 the State Department of Forestry has prepared maps for the state's sixteen fire protection districts. Approximately 60% of the state is included on these maps which are published at a scale of 1:126,720.

After critically examining Landsat 3 RBV images the Oregon State Department of Forestry (OSDF) felt the imagery could be used routinely for updating maps. The resolution was good enough to allow identification of recently constructed logging roads and road networks in new subdivisions. The imagery was also relatively free of many of the distortions usually present in aerial photography. Furthermore, the RBV imagery could be readily enlarged to directly overlay the published map scale (1:100,000 or 1:126,720).

The Walker Range Fire Protection Association District was selected to test the utility of Landsat 3 RBV data for updating fire protection district maps. Utilizing RBV data from the summer of 1978 and 1:100,000 USGS maps of LaPine and Crescent, RBV/map composites were produced, diazo copies made, and the composite distributed to OSDF personnel both in and outside of the Walker Range District. The composites were used to locate and map new subdivisions and the accompanying road networks. This information then provides the basis for a pre-fire protection plan. Priority areas, defined according to the potential loss of life and property and accessibility to these areas were noted with the aid of the composites. This type of fire protection planning utilizing satellite data has already paid off in the Cold Springs and Bridge Creek fires by providing valuable information in helping direct personnel and equipment to critical areas and thereby assisting in the containment and rehabilitation of these fires.

Actual costs for preparing an RBV/map composite of the Walker Range Fire Protection Association District, approximately 979 km², are as given in Table 1 and provide some idea of expenditures involved in utilizing RBV

data in an operational scheme.

Table 1. Cost of materials for RBV/map composite 1:100,000 coverage of State of Oregon Walker Range Fire Protection Association District.

<u>Materials and/or Activity</u>	<u>Amount</u>	<u>Cost per</u>	<u>Total Cost</u>
RBV diapositive images	3	\$10	\$30.00
Negative enlargements (5X)	1.1 m ²	\$34.50/m ²	\$38.00
Special order 1:100,000 USGS map composites (LaPine and Crescent*)	2	\$59	\$118.00
Materials to splice and mask negative**			\$265.00
Matte positive film for diazo printing**	2	\$8.75/m ²	\$17.50
Set of paper prints for plotting board	1 set	\$10.50/set	<u>\$10.50</u>
TOTAL COSTS			\$479.00
Diazo reproduction	1 set	\$0.55/set	\$ 0.55
Cost per km ² ***			\$0.50

* The base map, separates and materials to mask and mosaic negatives are the major expenditures (\$118 and \$265) and would be reduced to less than \$15 if already available.

** Includes compositing with map negative overlay.

*** RBV/map composites for a similar but larger region (40,000 km²) in the East Oregon Fire Protection District for which map separates were already held by OSDF were completed at a cost of less than \$0.01/km².

The total cost given in Table 1 does not include labor, a major expenditure, however some estimates of total elapsed time can be made. Elapsed time from when the order for the RBV from EROS Data Center (EDC) was placed to the preparation of the final product would range from six to ten weeks.

Other forestry related uses of Landsat 3 RBV are:

- 1) plotting areas of insect and disease infestation;
- 2) delineating areas for salvage timber sales related to diseased or insect-killed tree stands;
- 3) plotting forest fires;
- 4) monitoring clearcut logging operations.

In the first three applications the RBV imagery is primarily a base map that spotters use to locate themselves and record observed information. Monitoring clearcuts requires the identification of the clearcut on the RBV image and transferring that information to topographic maps.

Assuming the required RBV imagery is available, the major problem to date is tone matching of adjacent RBV images. The sharp tonal changes between images makes mosaicking more difficult and produces a less than desirable final product. Two other minor problems encountered are the occasional "lateral distortion" experienced with the RBV imagery and the apparent lack of standardization in evaluating cloud cover and image quality. Photographic enlargement of a standard Landsat 3 RBV negative (1:500,000) is limited to approximately five times the original image scale (1:100,000). The image starts to break up above the five times enlargement prohibiting enlargement to 1:62,500, a standard map scale, without serious image degradation.

Looking to the future, the most important concern is the prospect of NO MORE RBV data following the demise of Landsat 3. Presently there are no plans for a Landsat 3 "RBV type" sensor to be on board Landsat D. Assurances are given that the Thematic Mapper (TM) will be on board future Landsat satellites even though the TM will not be launched on Landsat D as anticipated. Unless the TM is ready within a year it probably means a two to five year gap in the acquisition of "RBV type" data from non-military spacecraft. Such a gap could seriously interfere with user acceptance of satellite data.

In summary, Landsat 3 RBV has many attributes not afforded by other Landsat imagery. Larger scale, improved resolution, and panchromatic coverage all combine to make the Landsat 3 RBV image comparable to high altitude aerial photography. This similarity plus low cost and little

geometric distortion helps the imagery gain acceptance with field and management personnel.

Landsat 3 RBV imagery has proven to be a reliable and cost effective data source for updating fireman's maps. Other documented forestry related uses are: 1) clearcut monitoring, 2) insect and disease infestation aerial surveillance, and 3) forest fire location. RBV coverage for the entire State of Oregon are being acquired and map updating with RBV/map composites continues.

II. ERSAL PROJECTS continued

B. CONTINUING PROJECTS FOR THE NASA OFFICE OF UNIVERSITY AFFAIRS

The following are reports on projects that are continuing beyond the period of 1 April 1979 through 31 March 1980.

WESTERN OREGON TIMBER CLEARCUT MONITORING PROJECT

Introduction and Background

The monitoring of clearcuts and the validation of clearcut permits on privately owned lands is under the jurisdiction of the Timber Assessment Division of the Oregon Department of Revenue (ODR) which has undergone several changes since the last annual report (1978-79). In April, 1980 Governor Victor Atiyeh directed the state agencies to reduce their annual mileage by 10% over the previous year. This has severely curtailed the effort devoted to field checking operations. Other fiscal related changes have brought about the elimination of the Mapping Section in the Timber Assessment Division and an overall reduction of funding. The number of field personnel has been decreased systematically from 75 to 55 over the past 5 years with four more positions to be eliminated this coming fiscal year. In addition to the reduction in field personnel, five full-time drafting positions were reduced to one half-time position when the Mapping Section was dissolved. More reductions are anticipated with the loss of timber related revenues brought about by the recent recession.

With the implementation of a timber severance tax in January, 1978 the required taxes are not paid by the landowner until the timber is harvested. In order to enforce this tax information on ownership, amount cut, and date of cutting are required. Date of cutting is important for determining when the tax is due and is also important in determining the time pro-rated penalty if the tax payment is delinquent.

Prior to December, 1979 the Tax Assessment Division monitored tree harvesting via harvest permits that landowners were required to file with the Oregon State Department of Forestry prior to cutting. Difficulty in and cost of field verification made checking any great number of permits

prohibitive. Occasionally, illegal clearcuts were discovered when field checking other cut-over lands or through casual conversations with a local knowledgeable of the area. Presently, two additional and more systematic techniques are employed. Each new technique represents an improvement but they are not without limitations. Both require the cooperation of private industry. In the first technique, lumber mills are responsible for determining and recording from whom the logs have been purchased. A second, and even more recently implemented method, is simply requesting maps of planned logging activities from the timber companies. The former technique utilizing mill records is time consuming and is not effective if 1) the ownership of the logs changes hands two or three times, or 2) the seller leaves the state following the sale.

Being dependent on maps prepared by those you wish to monitor has obvious limitations. It is also an almost impossible task to back-check an incorrectly written or recorded harvest permit. An apparent basic flaw in all of the systematic approaches above is the progression from permit records to field and/or photo documentation and not vice versa. A more logical, systematic, and cost effective approach would be the identification and delineation of clearcuts within a given time frame followed by the verification of valid permits from written records and maps. This identification and delineation process would require the use of an image format with the following qualities:

- 1) sufficient detail to resolve five acre clearcuts,
- 2) small scale to reduce the number of images for complete coverage and to cut down on the interpretation time,
- 3) adequate frequency of acquisition to provide coverage at least every three months during harvesting season, and
- 4) good geometric control.

Compositing Landsat RBV Imagery

Identification of large clearcuts on Landsat MSS bands 5 and 7 data or Landsat 3 RBV imagery is relatively easy due to the nearly complete tone reversal before and after timber harvesting. Prior to harvest the mature conifer forest presents a relatively low reflectivity value in the red (band 5) and near infrared (band 7) of the MSS system as well as the panchromatic coverage of the RBV (Figure 1). Following the harvest, reflectivity is increased and a light tone results (Figure 2). Utilizing a simple change detection technique, reported in the 1977-78 annual report, the change is obvious. In brief, this technique involves the use of a positive transparency (usually band 5 if MSS imagery is used) (Figure 1) of an early date overlaid with a negative transparency (also band 5) (Figure 2) of a later date. The net result (Figure 3) of this combination is to subtract out all of the areas that did NOT undergo change during the specified sampling dates. These areas of no change become medium gray and all of the tonal values above and below the medium gray tone indicate change, that may be due to clouds, soil moisture, water turbidity, snow cover, clearcutting, etc. In the case of clearcutting, the areas in question become a very dark gray and are quite visible on this positive/negative composite (Figure 3).

Accuracy of MSS Data for Monitoring Clearcuts

From cooperative work carried out with the Timber Assessment Division a pilot area was selected and tested using MSS data. Following the procedure outlined in the 1977-78 annual report, clearcuts were delineated on a 9 September 1977 and 31 May 1978 band 5 MSS positive/negative composite. A zoom transfer scope (Figure 4) was used to transfer the data to the



Figure 1. Positive Landsat 3 RBV of Crater Lake subscene A taken prior to cutting (2 August 1978). North is to the left of the image and scale is approximately 1:350,000. Scene identification number is 30150-18162-A.



Figure 2. Negative Landsat 3 RBV of Crater Lake subscene A taken after clearcutting (28 July 1979). North is to the left of the image and scale is approximately 1:350,000. Scene identification number is 30510-18153-A.

ORIGINAL PAGE IS
OF HIGH QUALITY

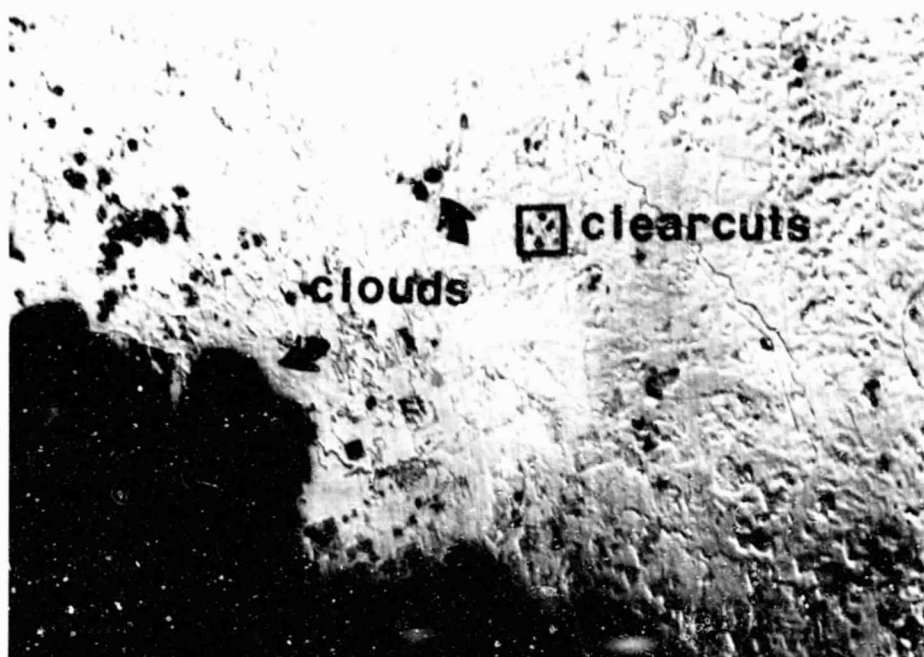


Figure 3. Composite of pre-cut positive (2 August 1978) and post-cut negative (28 July 1979) Landsat 3 RBV images. Acres of clearcutting and clouds appear dark on the composite. Scale is approximately 1:350,000. North is to the left and the scene identification numbers are 30150-18162-A and 30510-18153-A.

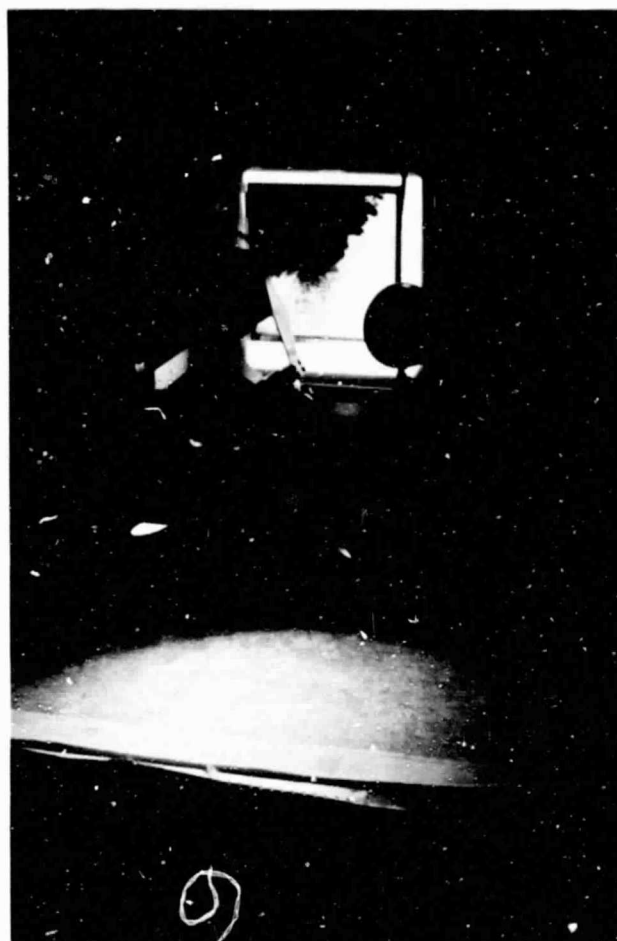


Figure 4. Set-up for transferring the clearcut information from the composite of two Landsat dates to the 1:125,000 topographic sheets.

ORIGINAL PAGE IS
OF POOR QUALITY

appropriate 1:125,000 topographic sheets (Roseburg and Medford) (Figure 5'. Eighty-nine new clearcuts ranging from 15 to 100 acres in size were identified on the multirate Landsat imagery, however because of limited photographic coverage available for verification only 40 sites could be checked on the 1979 township centered Oregon State Department of Forestry's aerial photography (Figure 6). The results are as follows:

Clearcuts accurately identified and located	60%
Clearcuts accurately identified but located in the wrong section	17%
Clearcuts misinterpreted	23%
Total	<hr/> 100%

Although the number of misinterpreted clearcuts was higher than anticipated, most of the misinterpretations were accounted for and found to be related to other changes over time, such as agricultural change and mining/quarrying production. The tonal change (dark to light) and regular polygonal shape associated with clearcutting is also found with the ripening of grain, cutting of hay, or the vegetation disturbance brought about by surface mining. Fortunately these activities are frequently confined to valley bottomland and can be eliminated when the initially interpreted clearcuts are transferred to the 1:125,000 topographic maps. Appropriate symbols/colors on the topographic maps indicate surface mining activities and nonforested land.

Clouds also create interpretation problems with this type of change detection technique, but can be detected and eliminated by careful examination of the images. The location of a cloud shadow in conjunction with the cloud is often a good key to the identification of a cloud.



Figure 5. Example of the clearcut information transferred to 1:125,000 topographic maps. Data represents clearcutting during the 2 August 1978 - 28 July 1979 time period.

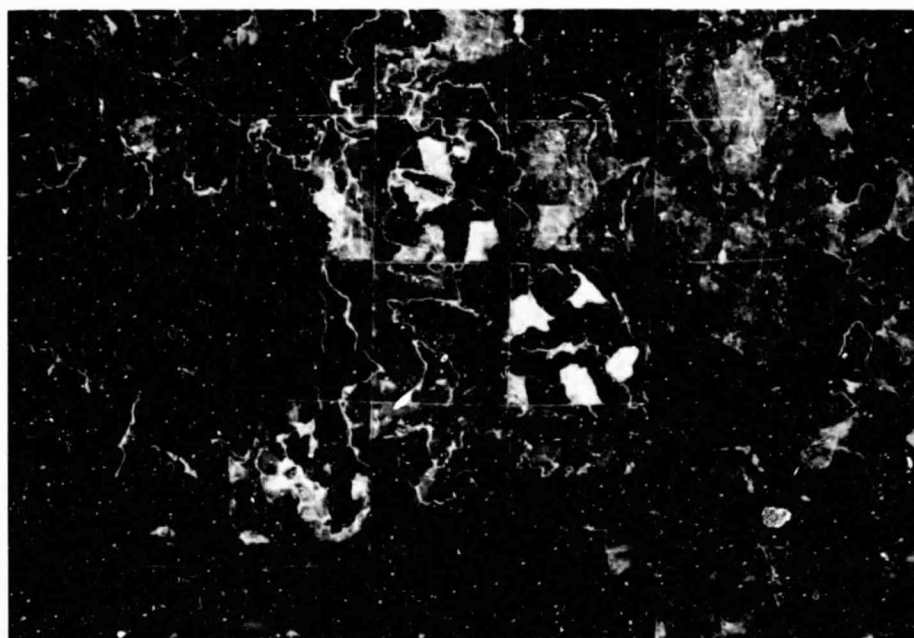


Figure 6. Oregon State Department of Forestry's township-centered aerial photography used to verify the clearcuts interpreted from Landsat 3 RBV. North is at the top of the photo and the scale is approximately 1:45,000.

ORIGINAL PAGE IS
OF POOR QUALITY

Reasons for Using RBV Imagery

Landsat 3 RBV data has several advantages over MSS data from Landsat 1, 2, or 3 and RBV data from Landsat 1 and 2. They are as follows:

1. Better resolution (79 meter cell to approximately a 35 meter cell) brought about by increasing the focal length of the camera system by 1.89 times and reducing the exposure time by widening the recorded spectral range.
2. Larger original nominal scale (1:1,000,000 to 1:500,000) by the 1.89 times increase in the focal length.

Both of the above improvements are important to the identification and location of clearcuts. Better resolution means improved detection of smaller parcels of clearcuts and the larger-scale format permits enlargement to scales not possible before (Figure 7). Better geometric fidelity is an added value of RBV over MSS data. Image distortion of the Landsat RBV data is less than 1%.

Accuracy of RBV Data

RBV subscenes A and C of Crater Lake (2 August 1978 and 28 July 1979) (Figures 1 and 2) were selected to evaluate the accuracy of interpretation and location of clearcuts. The procedure was the same as that used for change detection with MSS data - two images with the earlier date being a positive transparency and a negative transparency for the later date. An additional positive transparency was acquired for the later date to help verify cloud cover (Figure 8).

Interpretation was easier and more accurate with the RBV data than with MSS data due primarily to the RBV's larger scale. The evaluation indicated that more than 90% of the clearcuts can be correctly identified



Figure 7. Tentimes enlargement from the 2 August 1978 Landsat 3 RBV Crater Lake subscene A. North is to the left of the image and the scale is approximately 1:50,000.

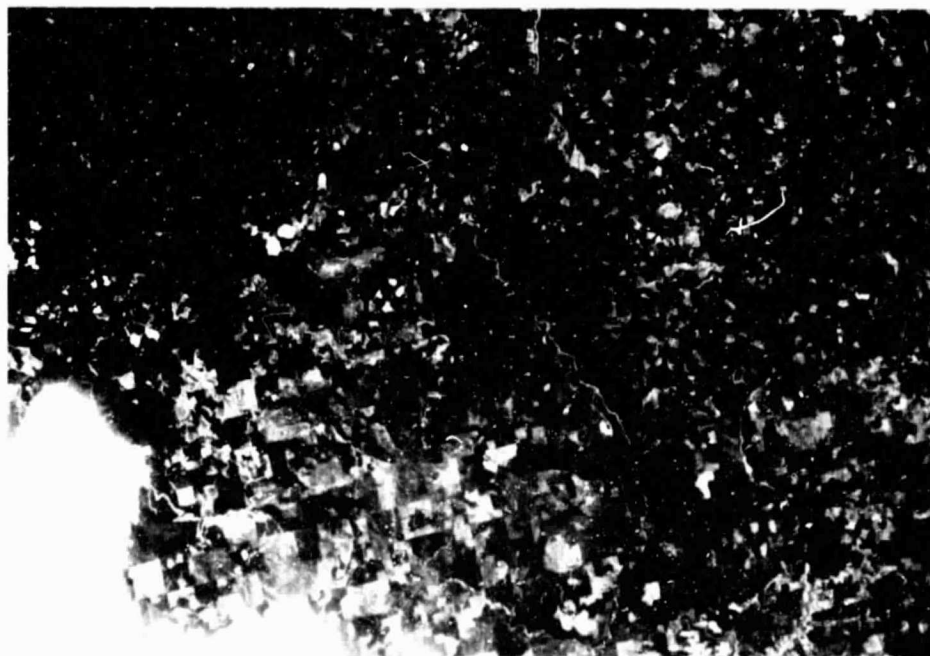


Figure 8. Positive of Landsat 3 RBV of Crater Lake subscene A (28 July 1979) used to help identify clouds from clearcuts. Note the cloud shadows that are visible to the northwest of the clouds because of sun azimuth and site latitude.

ORIGINAL PAGE IS
OF POOR QUALITY

and located within one section. The smallest clearcut interpretable was improved from 15 acres on Landsat MSS imagery to 2 acres on Landsat 3 RBV imagery.

Future Plans

Although personnel from the Timber Division were impressed by the accuracy of RBV data and agree on its potential value, staff reductions and funding cuts continue to burden the Division to the point where innovations, no matter how valuable, are difficult to introduce. Before any RBV is accepted, several tests of accuracy and consistency will need to be undertaken and the technique proven without a doubt to be accurate, reliable, and cost effective.

The first large area test is in the planning stage. A test site is being selected by personnel from the Timber Division. RBV imagery for Fall, 1979 and Summer, 1980 will be selected, ordered and interpreted for clearcuts. Accuracy, minimum detection size, and cost will be documented.

WHEAT DISEASE DETECTION AND MONITORING

Even though diseases have been detected in wheat and other crops by means of infrared aerial photography (Colwell, 1956¹; Manzer and Cooper, 1967²), this has not been done routinely in Oregon. Several candidate plant diseases found in the Pacific Northwest are being studied by pest management specialists and agronomists for the purpose of developing practical disease monitoring procedures. The existence of an ongoing cooperative experiment involving investigations of wheat diseases and fertilization at the Oregon State University Departments of Soil Science and Botany and Plant Pathology provided an opportunity to utilize established field trials with a wide range of controlled variation. Such variation is critical in developing photographic interpretive capability so that the feasibility of identifying and detecting specific diseases can be studied in the context of the highly variable conditions present in an operational disease monitoring environment.

Test sites in both western and eastern Oregon were selected for the experiment. Four Oregon State University experimental plots formed the basis for testing in western Oregon whereas corporate farms were used in eastern Oregon. Nine air photo missions have been conducted in western Oregon, four in April, three in May, one each in June and July. A total of five air photo flights have been carried out in eastern Oregon, one in March, two in April and two in June. The majority of the flights have exclusively used color infrared film, however, both standard color and black and white infrared film have also been acquired. Of the three, color

¹ Colwell, R.N. 1956. Determining the prevalence of certain cereal crop diseases by means of aerial photography. Hilgardia, V. 26, No. 5, pp. 223-286.

² Manzer, F.E. and G.R. Cooper. 1967. Aerial photographic methods of potato disease detection. Maine Agricultural Experiment Station Bulletin 646. 13 p.

infrared proved to be the most valuable and represents the primary data source.

Although less than mid-way into the photo interpretation phase of the study several general conclusions are evident. One important and already known observation that bears repeating is that agricultural operations in such markedly different locations as eastern and western Oregon must be considered as separate entities. The reasons for this are related in a very complex fashion to physical factors (climate, topography, soils, etc.), cultural factors (farming practices, crop preference, crop calendar, etc.), and economic factors (cost of water, feed, fertilizer, market opportunities, etc.). This is evident in the preliminary conclusions made concerning the detection and successful management of "take-all", a major wheat disease. Although in both western and eastern Oregon the detection of "take-all" was accomplished with color infrared aerial photography, the successful implementation of this information will likely be possible only in eastern Oregon and not western Oregon because of various constraints of management and timing. In eastern Oregon irregular patterns of stress were noted on the color infrared photography. Ground checks were conducted and the presence of "take-all" was confirmed; conversely, "take-all" was not present in areas that did not show as being stressed. Because of this detection early in the growing season (late May), management options were still open and farm managers were able to avoid losses from reduced grain yield attributed to "take-all" and capitalize on the relatively high value of hay. The owner harvested for hay rather than grain, which allowed the earlier planting of an additional crop in the multicrop agricultural operation and helped convert additional losses into potential gains.

Two other aspects of the experiment involve utilizing color infrared photography in an attempt to correlate the variation of color saturation

in the image of wheat with field measurements of plant water potential and crop yield through a wide range of plant vigor conditions. The development of a crop yield prediction capability via the interpretation of color infrared aerial photography is a major goal.

LAND USE MONITORING PROJECTS FOR TAX ASSESSMENT -
UMATILLA, LAKE, AND MORROW COUNTY ASSESSORS' OFFICES

The use of Landsat 3 RBV imagery by county assessors' offices in Oregon focuses primarily around the updating of land use information. The need for an annual updating of land use is due to the rapid change in land use and the large increase in assessed value per acre associated with some land use changes. The following documents the use of Landsat 3 RBV imagery by the Umatilla County Tax Assessor's Office in an application identical to that made in neighboring Morrow County (previously reported). The major difference between the two applications was the primary data base: RBV vs. MSS imagery.

Revised land use acreage figures from Umatilla County provide documentation of the value of Landsat 3 RBV. Using 1978 RBV imagery 48 new center pivot irrigation systems were located in western Umatilla County. The center pivot owners were then given notification of a new tax assessment and informed of the requirement that they update the tax assessors' records regarding land use change. The change in land value assessments not only depends on the land use change but also the type of irrigation system used. For example, Class 7 (sand and sagebrush) land is valued at \$3/acre; whereas Class 4 (irrigated) land is valued at \$500/acre or \$850/acre depending on whether a standard irrigation system or a center pivot system is installed. The center pivot system is assessed at a higher rate.

Most center pivot systems irrigate 125 acres and are established on rangelands. The increased assessed value for each 125 acre field is therefore \$847/acre x 125 acres, \$105,875. Occasionally an area that is being irrigated with wheel lines or hand sets is converted to irrigation by center pivot. In this case the increase in assessed valuation

for each 125 acre field is \$350/acre x 125 acres, or \$43,750. By far, most of the land use conversions involve the establishment of center pivots on rangeland. In 1978, the assessed value for the county rose nearly 5.1 million dollars due solely to the establishment of center pivot irrigation systems, a sizeable amount for a rural county of 53,900 people.

Not only is it cost effective to utilize Landsat imagery in the land use assessment process rather than to depend solely on field survey data by county agents or individual farmers, but the use of the satellite imagery has significant benefits due to the rapidity with which the information regarding land use changes can be made available and be utilized in the assessment and taxation processes. The very activity of establishing the center pivots, and then conducting the intensive agricultural practices associated with high production agriculture, means more heavy traffic on the roads and more demands on people oriented services: hospitals, police, schools, etc. Real time assessment and taxation as opposed to one or two year delays in these adjustments means that the financial load for funding public services is more equitably distributed and appropriately increased in accordance with incurred use of facilities and services.

The major deterrent to promoting the use of Landsat 3 RBV imagery has been its lack of availability and delays in obtaining RBV imagery that has been acquired for NASA. For example, the arrival of Landsat 3 RBV data from the EROS Data Center for the 1979 growing season was delayed due to processing difficulties at Goddard Space Flight Center and only became available during Spring 1980. This has severely limited the use of 1979 data until after the 1980 growing season when the assessors are back in the office following their field data collection season. However, despite these difficulties there has been enough interest and positive

feedback within the various county tax assessor's offices that ERSAL personnel have been asked to give a two-hour presentation on the applications of Landsat data, especially RBV, to approximately 150 county tax assessors and State Department of Revenue personnel. The presentation will be given at the annual week long tax assessors' workshop held in August at Oregon State University.

APPLICATION PROJECTS USING OREGON AIR NATIONAL GUARD THERMAL INFRARED SCANNING DATA

Two studies utilizing Oregon Air National Guard Thermal Infrared imagery were initiated in 1978. One study was focused around collecting information on the recreational use of the Deschutes River to assist the State Marine Board in making regulatory decisions regarding the use of the Deschutes River. The second study was a cooperative study with Portland Corps of Engineers and ERSAL to detect excessive seepage from earth and rock fill dams in the southern Willamette Valley. Thermal infrared imagery was not acquired until early September, 1979.

The data acquired during the mid-afternoon of a week day (8 September 1979) was judged to be unusable for the Deschutes River Recreation Study because the time and date of the acquisition would not properly indicate density of campers that utilize the area. The detection and quantification of use is dependent on recognition of campfires and multiplication by a predetermined camper/campfire ratio. Detection of recreation users with the imagery provided has two major limitations. First, the date the imagery was acquired was after the last weekend of the traditional summer holiday season, Labor Day weekend, and was in the middle of the week. Second, the time of day (mid-afternoon) is inappropriate for imaging since most of the recreation users will not have set up camp or started a fire before early evening. Interpretation from the imagery would not be representative of recreational use.

The time and date constraints were not as critical for the Earthen Dam Study although pre-dawn coverage would have been useful. An evaluation of the original negative data collected on 7 September 1979 was made. Nine dams (Blue River, Cougar, Hills Creek, Lookout Point, Dexter, Fall Creek, Dorena, Cottage Grove and Fern Ridge) were imaged from an altitude

of 1,000 feet with opposing flight lines (one N-S and the other E-W).

An evaluation of the thermal imagery indicates that five of the nine earthen dams (Fern Ridge, Cottage Grove, Fall Creek, Blue River, and Cougar) show no evidence of seepage. Two more dams (Dexter and Hills Creek) have very minor indications of possible seepage (narrow bands of vegetation). Lookout Point and Dorena Dams are the only dams that have sufficient indication of seepage zone to warrant further investigation. Verification of the thermal infrared interpretation on available aerial photography has been completed and a brief report prepared for, but not reviewed by, the Corps of Engineers.

II. ERSAL PROJECTS continued

C. ERSAL PROJECTS FUNDED THROUGH OUTSIDE AGENCY SUPPORT

The following are projects that have been or are being conducted by ERSAL through funding other than ERSAL's NASA grant during the reporting period 1 April 1979 to 31 March 1980. These projects have been conducted with various federal and state agencies in Oregon using their funds to support the projects. These projects do not meet the criteria of utilizing remote sensing as the sole information base for decision-making and of being short-term projects having high impact. Usually these projects involve longer term decision-making or are demonstration projects for the state and federal agencies to indicate the applicability of Landsat imagery and U-2 photography for decision-making procedures.

These agencies became aware of NASA-sponsored applications projects being conducted at ERSAL, and were interested in utilizing remote sensing technology. Upon consultation and advisement from ERSAL, several agencies decided to conduct remote sensing applications projects. The following are example projects conducted by ERSAL and funded by agencies other than NASA.

REMOTE SENSING INVENTORY OF ELK IN THE BLUE MOUNTAINS

The extent and distribution of elk habitat in the Blue Mountains of eastern Oregon is directly affected by ongoing timber and livestock management practices. Since elk require access to several types of habitat for foraging and protection from weather extremes, suitability of habitat is continually changing. This creates a dilemma for wildlife managers charged with implementing specific management actions, such as issuance of a certain number of hunting permits on the basis of habitat data which may be out of date, erroneous, or non-existent. To provide the information upon which such actions may be based, and to minimize the potential conflict arising from common use of resources by elk and livestock and from the implementation of timber harvesting plans, the Oregon Department of Fish and Wildlife has undertaken studies to document elk habitat use and to develop area-wide inventory techniques. Accordingly, an inventory of forest and grassland vegetation types that provide elk cover and forage was developed for the Blue Mountains using remotely sensed data. Elk habitat was measured by mapping cover and forage extent in two locations: 1) a northern area of 125,000 acres along the South Fork of the Walla Walla River and around Jubilee Lake; 2) a southern area of 264,000 acres around Bridge Creek Flats and along the North Fork of the John Day River. Fall herds occupying the management units in the north and south study areas are estimated at 3650 and 6220 adult elk, respectively.

Actual use by elk of various habitats was documented. Elk were tagged with radios, followed, and their activity observed to record specific use of all habitats throughout the year. Temperature, wind and other specific environmental conditions within the habitats were noted during use. Elk behavior was analyzed with habitat structure, plant composition, and weather conditions.

Forest and grasslands within both study areas are representative of elk habitat classes found throughout the Blue Mountains. Mixed conifer is the most abundant tree-dominated resource class throughout these areas. Spruce-fir is of secondary extent in the north; lodgepole pine in the south. Bluebunch wheatgrass is the prevalent grass-forb resource class on elk winter ranges, but introduced grass-forb classes are prominent in logged areas of summer ranges. Elk use these and other resource classes primarily for either cover or forage depending on their extent, intermixture, and structure (tree height and canopy closures are structural qualities).

The inventory of cover and forage areas was performed using Landsat satellite data and aerial photography. First, the satellite data were subjected to analysis by a modified unsupervised classified. Spectral classes derived from Landsat data were associated with resource classes recognized from aerial photographs and then were condensed into habitat classes that elk were observed to use as forage or cover. Maps and acreage tables of spectral, resource, and habitat classes for the study areas were saved on separate computer files. Data from small areas are retrievable for detailed study and data from larger portions may be regrouped and manipulated for further evaluation.

A qualitative comparison of resource and habitat classes with the computer-determined spectral classes was conducted and the habitat map was judged realistic and adequate. Further quantitative evaluations have been designed to estimate accuracy levels. Approximately 500 localized descriptions of habitat structure and composition obtained from stands where elk were observed will be compared with spectral classes in each area. These comparisons of areas occupied by elk with the same areas on the satellite maps will provide assessments of accuracy and error so that the land manager can evaluate the impacts of various degrees of error

in the context of specific resource-management decisions.

The elk habitat, resource, and spectral maps based on Landsat data can be displayed and manipulated for input into the land-management decision-making process. This information can be used for monitoring habitat status and change because it is a numerical record tied to geographic coordinates and is stored on and accessible from a computer. The research data has been extended to mapping of elk habitats in the Heppner wildlife management unit, with Oregon Department of Fish and Wildlife and U.S. Forest Service managers using the research information in land-use planning dialogues. Habitat maps and acreage tables will become a basis for monitoring management of elk herds through planned manipulations of cover-forage areas and ratios. The measurement of elk habitat distribution and cover-forage area ratios over time provide managers and planners with previously unavailable data. Such data are necessary for informed management decisions that will allow Oregonians to have productive elk habitat as well as timber and forage resources.

ESTIMATION OF BURNED AGRICULTURAL ACREAGE IN THE WILLAMETTE VALLEY

During the past year ERSAL prepared an estimate of burned agricultural acreage in the Willamette Valley for the 1979 summer field burning season. The 1979 estimate, based on data from a systematic sample that involved stratification with Landsat imagery and direct aerial observations, provided the Oregon Department of Environmental Quality (DEQ) with its first objective evidence of the actual number of acres burned in a season. The estimate of 211,909 acres burned, \pm 38,911 acres (90% confidence interval), given to the Smoke Management Section of DEQ exceeded the reported burned acreage by 58,936 acres. Each acre that a farmer wishes to burn must first be registered (\$1/acre) and then given final approval on the day of burning (burn permit is \$2.50/acre). Assuming that all the unreported burned acreage had at least been registered, the Smoke Management Section suffered unrealized revenues of an estimated minimum of \$147,340.

Unreported burned acreage may contribute to smoke intrusions into urban areas. The DEQ Smoke Management Section seeks to control such intrusions. At the very least, the associated unpaid permit fees represent lost opportunities for financing additional research of issues related to field burning. In response to this situation the Smoke Management Section took the following actions: 1) met with industry representatives and the Seed Growers Council to enlist greater industry participation in securing compliance among its members, 2) met with Fire District officials to secure greater assistance in stricter management of field burning, 3) hired an additional field inspector to seek violators of burning regulations, and 4) requested a proposal from ERSAL, and subsequently funded that proposal, to estimate the 1980 total acreage burned both for comparison to the estimate prepared by ERSAL for 1979 and for assessing the effect of new laws and operating rules for coming field

burning seasons.

Much of the agricultural acreage in the Willamette Valley has been utilized for the production of various annual and perennial grass seed crops. These crops are tolerant of the poorly drained, clay-type soils present in the Valley, particularly in the southern half of the Valley. In the 1940's, 50's, and 60's the farmers burned fields primarily at times of their own choosing. As many as 280,000 acres would be burned each year during the July-October burning season; most of the burning would occur in August. The burn was, and is, being conducted in a valley that is subject to restricted natural ventilation during the late summer and early fall. Stagnating air in the Willamette basin tends to concentrate the smoke from field burning in the south end of the valley. Between 1945 and 1960 the human population of the south valley (primarily the Eugene/Springfield metropolitan area) more than doubled. Sensitivity to smoke intrusions grew and pressure intensified for elimination of the field burning practice, or at the very least, for its strict regulation. In an effort to reduce the occurrence of smoke intrusions into urban areas the Oregon Legislature mandated the establishment of a smoke management program to begin operation in 1975.

The first years of the program met with strong opposition and lack of cooperation from the grass seed industry. However, incentives (to avoid severe restrictions on total allowable burn) have materialized for the industry to assume an active positive role in smoke management efforts. Based upon the actual total acres burned in recent years it seems that most of the acreage farmers would like to burn can be in fact burned with few instances of smoke intrusions when the burning is regulated with an eye toward meteorological and field moisture conditions. Without such care, the burning would cause many smoke intrusions, complaints would result and the industry would probably be limited to a maximum of 50,000 acres burned each year (17% of the registered acres, 28% of the 1979 maximum allowable burn, and 20% of the 1980 allowable

burn). Although the incentive to cooperate with smoke management efforts is substantial, there are still those who choose to disregard those efforts and conduct illegal burns. Most illegal burns are thought to occur on days when tens of thousands of acres are legally burned and some farmers under-report burned acreage, so as not to exceed their allotted quota.

To assess the magnitude of this under-reporting the DEQ contracted ERSAL to conduct a survey to estimate the total burned agricultural acreage in the Willamette Valley. Landsat images acquired in 1973 and 1974 (prior to implementation of smoke management and therefore representative of maximum potentially burnable area) were used to stratify the Valley into potentially burnable vs. not potentially burnable. A stratified sample consisting of a systematic selection of observation points along parallel, regularly distributed, east-west transects across the Valley provided the needed data. This sample of 662 observation points along the transects represented 2,118,972 acres of Willamette Valley agricultural land. Observations of the points were made from a light aircraft on nine occasions through the burning season from July 10th to October 5th. Each point was viewed repeatedly through the burning season until it was burned. The results were evidence of substantial under-reporting of burned acreage. These results and the subsequent actions they precipitated demonstrated a useful and practical contribution to the operations of a state agency charged with managing and mitigating a very sensitive situation. The DEQ utilization of ERSAL capabilities for a second year, with funds generated by permit fees, indicates that this method of sampling offers them an economically viable alternative for acquiring the estimation of burned acreage.

NATURAL RESOURCE INVENTORY OF DESCHUTES COUNTY

ERSAL has been funded by the Deschutes County Planning Department to provide a resource map of that entire 1.9 million acre central Oregon county. The locational and quantitative information derived from this work will be incorporated into the resource allocation and management decisions critical to such a rapidly changing demographic area. The final mapping is to be at a scale of 1:24,000 and presented by individual 7.5 minute USGS topographic quadrangles. Digitally processed Landsat MSS data provides the basis for the forest and rangeland information while the agricultural areas will be mapped from U-2 high altitude aircraft photography. Various temporal scenes of Landsat false-color composites will also be used to assist in crop identification and for differentiating farming practices (primarily irrigated vs. non-irrigated).

In addition to the funding of ERSAL's work, the planning department has allocated one full-time staff position to the 18-month project. This staff member works closely with ERSAL personnel and acts primarily as a catalyst with various local, state, and federal agency representatives. Technical advice and improved access to existing resource data is being solicited from skilled resource specialists within those various agencies. The county staff position serves as a vehicle for acquainting field personnel with the ongoing project and demonstrating how the various agencies' resource information can be included into the work effort. The county staff person is responsible for the direct integration of the inventory products into the activities of the Deschutes County Planning Department and identifying further opportunities for use of the data by other local governmental offices.

LANDSAT DIGITAL WORKSHOP

During March 24-26, 1980, a Landsat Digital Workshop was offered by the Environmental Remote Sensing Applications Laboratory with partial financial support from the Pacific Northwest Regional Commission (PNRC). The workshop was held on the Oregon State University campus and was attended by fifteen personnel from federal, state, and county agencies and several universities. Twelve of the participants were from Oregon and three were from the state of Washington.

Lectures and labs were conducted covering a wide range of topics on remote sensing including 1) an introduction to remote sensing, 2) air photo interpretation and mensuration, 3) introduction to Landsat systems and data output and their availability, 4) the interpretation of Landsat imagery and digital data, 5) machine processing of Landsat data, and 6) an introduction to PIXSYS including spectral classification, training site selection, and grouping and labeling. Presentations on the accuracy of cartographic and analytical products derived from remotely sensed data and several case studies were also given.

Approximately one-half of the three day workshop was devoted to lab exercises and hands-on experience. Computer printouts, instructional maps, and other remote sensing related materials were provided prior to, during, and following the workshop. This technique allowed the participants to do pre-workshop preparation, as well as providing post-workshop follow-up and reinforcement.

Participant evaluations were excellent and more workshops are planned.

II. ERSAL PROJECTS continued

SUMMARY OF PROJECTS FUNDED BY SOURCES OTHER THAN NASA OFFICE OF UNIVERSITY AFFAIRS

Since its beginning in 1972, ERSAL has engaged in several projects that have been funded by agencies other than the NASA Office of University Affairs. Table 1 shows all of these types of projects engaged in since the inception of ERSAL. This table indicates the general nature of each project, the type of imagery utilized and the level of support provided.

Table 1. PROJECTS FUNDED BY SOURCES OTHER THAN NASA UNIVERSITY PROGRAMS

<u>Project Title</u>	<u>Agency</u>	<u>Imagery Used</u>	<u>Financing</u>
Natural Area Preserves	Natural Area Preserves Advisory Committee, State Division of Lands	U-2 color IR 1:125,000	\$21,500
Douglas Co. Timber Inventory	Oregon Dept. of Forestry	Landsat MSS CCT, aerial photography: 1:125,000 CIR, 1:60,000 B & W, 1:4,000 color	\$20,550
Tansy Ragwort Plotting and Mapping	Oregon Dept. of Agriculture	Landsat MSS CCT, 35 mm color a/p	\$10,850
Water Resources State-wide Inventory	Oregon Dept. of Water Resources	Landsat MSS FCC, 1:125,000 CIR, 1:24,000 orthophoto sheets	\$26,408 \$40,692
Oregon Land Use Maps	Pacific Northwest Regional Commission (PNRC)	Landsat MSS FCC	\$ 2,024
Landsat Data Analysis Workshop	PNRC	Landsat MSS CCT	\$ 5,280
Landsat Data Analysis Workshop II	PNRC	Landsat MSS CCT	\$ 9,008
Remote Sensing in Resource Analysis (Univ. course)	PNRC	Landsat MSS CCT	\$11,387
Large Area Multiple Resource Inventories	PNRC	Landsat MSS CCT	\$10,000
Crump Lake Veg. Inventory	U.S. Fish & Wildlife Service (USFWS)	1:125,000 CIR	\$ 1,690
Days Creek Inventory	USFWS	Landsat MSS CCT	\$ 2,495
Malheur Lake Inventory	USFWS	Landsat MSS CCT 1:6,000 CIR a/p	\$14,980

PROJECTS FUNDED BY SOURCES OTHER THAN NASA UNIVERSITY PROGRAMS (cont'd.)

<u>Project Title</u>	<u>Agency</u>	<u>Imagery Used</u>	<u>Financing</u>
Eel Grass Mapping	USFWS	Landsat MSS CCT 1:20,000 color a/p	\$12,320
Western Oregon Wetlands Inventory	USFWS	1:80,000 B & W a/p	\$46,940
Calapooia Inventory	Soil Conservation Service (SCS)	Landsat MSS CCT	\$ 6,500
Thomas-Cottonwood Watershed Management Planning	SCS	Landsat MSS CCT, 1:6,000 CIR a/p	\$ 8,500
Columbia Basin 208 Study	SCS	Landsat MSS CCT, 1:125,000 CIR a/p 1:24,000 orthophoto sheets	\$77,794 \$ 3,700
Tillamook Watershed Management Planning	U.S. Forest Service (USFS)	Landsat MSS CCT, 1:125,000 CIR a/p	\$ 7,000
Thomas-Cottonwood Documentation	USFS	Landsat MSS CCT, 1:6,000 CIR a/p	\$ 1,500
Landsat Analysis Handbook	USFS	Landsat MSS CCT	\$14,996
Landsat Analysis Assistance	USFS	Landsat MSS CCT, 1:6,000 CIR a/p	\$13,906 \$ 7,370
Polygon Plotting (software development)	ESL, Inc.	Landsat MSS CCT	\$ 3,960
Northeast Oregon Elk Habitat Analysis	Oregon Dept. of Fish and Wildlife	Landsat MSS CCT 1:6,000 CIR a/p	\$15,619 \$18,707
Application of Landsat Data to the Management and Quantification of Agricultural Field Burning in the Willamette Valley	Oregon Dept. of Environmental Quality	Landsat MSS hardcopy, Landsat III RBV	\$14,997

PROJECTS FUNDED BY SOURCES OTHER THAN NASA UNIVERSITY PROGRAMS (cont'd.)

<u>Project Title</u>	<u>Agency</u>	<u>Imagery Used</u>	<u>Financing</u>
Natural Resource Inventory of Deschutes County	Deschutes County, Oregon Planning Department	Landsat MSS CCT	\$65,330

II. ERSAL PROJECTS continued

D. FUTURE PROJECTS

In Oregon, as elsewhere, the hardship of the nation's economic recession is being steadily intensified. There now is forecasted a state revenue shortfall on the order of \$204 million. Oregon state agencies are being forced to implement program and/or personnel adjustments to accomplish a 30% reduction in their budgets for July 1, 1980 - June 30, 1981. The program expenditures that are the first to be eliminated are the "out-of-house" expenditures: the types of contracts that ERSAL currently receive from the Oregon Department of Fish and Wildlife. Therefore, we cannot expect to be very successful in obtaining contractual support from the state agencies during this time period.¹ That is the negative side of the picture.

We see in this set of circumstances a unique opportunity to capitalize on the existing hardships. As noted earlier in this report, the Oregon Department of Revenue has experienced in one section a staff reduction of 30%; most of these were field personnel. This reduction occurred largely due to a change in the method and training of taxing timber. Additional personnel cuts will be made in this department as well as in others due to the recession induced budget cuts. Accompanying loss of staff are severe restrictions on travel. Despite these adverse developments agencies will be expected to continue to perform many of their functions and services. We believe that remotely sensed data, in particular, will be needed to help offset the impacts that result from loss of field personnel and travel opportunities. ERSAL will be making a concerted effort to induce remote sensing efforts in the vacuum created by the recession. This opportunity

¹ Oregon State Fish and Wildlife is continuing to plan for modest expenditures at ERSAL following July 1, 1981 for large herbivor (elk, deer, antelope) habitat assessments.

represents the positive side of the picture.

ERSAL has been approached by the Pacific Northwest Forest and Range Experiment Station to provide consultation and planning for evaluating remote sensing capabilities for the inventory of dead and down timber as an energy source. We will be alert for applications that would meet the criteria for the NASA University Affairs grant, as well as project opportunities to be supported by the Pacific Northwest Forest and Range Experiment Station.

ERSAL staff will continue to emphasize applications and project development using Landsat 3 RBV data for several reasons:

- A. The applications potential for this higher resolution imagery substantial and agencies of different disciplines may be able to generate new applications that were previously not feasible.
- B. When the digital form of RBV data becomes available it will represent another form of the high resolution data the potential of which is yet to be examined. Several possibilities for use of the digital data include: a) edge-enhancement and contrast-stretching of the data to emphasize border features, i.e. roads, timber clearcut boundaries, water-land boundaries, urban road networks, and b) stratifying the data to enhance surface features characterized by specific reflectance values.
- C. The potential for use of RBV imagery in combination with other data forms is proving to be valuable. RBV imagery could potentially be combined or composited with Landsat MSS, Heat Capacity Mapping Satellite imagery, other satellite imagery, various aerial photography, and map bases that require updating. The RBV imagery provides a planimetric image of the earth's surface that is

virtually free of tilt, tip and crab commonly found in aerial photography. As a result, the RBV imagery can act as a planimetric map base and locating device when combined with other forms of data.

- D. The scale of Landsat 3 RBV data is very similar to the scale projected for Landsat D Thematic Mapper data. Consequently, agency personnel that are accustomed to working with the current scale of Landsat 3 RBV data should have no trouble in adapting to and applying Landsat D Thematic Mapper data that will also have more wavelengths of data available for applications.

APPENDIX

ERSAL EMPLOYEE RESUMES

Alexander, Cassandra J.

Born: 13 December 1951

Degrees: B.S., 1975, Oregon State University, Corvallis, Oregon

Positions: Laboratory Assistant, Environmental Remote Sensing Applications Laboratory, Oregon State University, 1973 - 1975.
Remote Sensing Applications Assistant Scientist (Research Assistant), Environmental Remote Sensing Applications Laboratory, Oregon State University, 1976 - present.

Professional Field: Botany, Vegetation Ecology, Remote Sensing.

Selected Publications:

Walsh, Stephen J., John W. Mairs, and Cassandra J. Alexander. 1976. Vegetation inventory of certain state-owned lands in selected Oregon counties (Northwest Oregon). A report to the Natural Area Preserves Advisory Committee, Oregon State Land Board. Submitted by the Environmental Remote Sensing Applications Laboratory, Oregon State University, Corvallis, 60 pp.

ERSAL, 1974. Oregon - a color mosaic constructed from 26 Earth Resources Technology Satellite Images. Environmental Remote Sensing Applications Laboratory, Oregon State University, Corvallis, Oregon. A photograph. (Color reconstituted, color balanced images prepared by Cassandra J. Alexander).

Isaacson, D., C. Alexander, B. Schrumph and R. Murray. 1979. Analysis of association of Landsat spectral classes with ground cover classes in wildland inventories. In press in: Proceedings of the International Union of Forest Research Organizations. Mosccw, Idaho, Sept. 21, 1979.

Appendix
Resume

Hall, Madeline J.

Born: 26 November 1951

Degrees: B.A., 1974, Macalester College, St. Paul, Minnesota
M.S., 1976, Oregon State University, Corvallis

Positions: Graduate Teaching Assistant, Department of Geography,
Oregon State University, Corvallis, Oregon, Maps and
Map Interpretation, Sept. 1974 - June, 1975;
Geographer, U.S. Environmental Protection Agency, Corvallis
Environmental Research Laboratory, Land Use Section, Corvallis,
Oregon, Aug. 1975 - Sept. 1976;
Research Assistant, Environmental Remote Sensing Applications
Laboratory, Corvallis, Oregon, Nov. 1976 - present.

Professional Field: Physical Geography, Geomorphology, Biogeography,
Land Use Analysis, Natural Resource Inventory and Management,
Air Photo interpretation/Remote Sensing.

Professional Recognition: Oregon Academy of Science

Selected Publications:

Hall, M.J. 1977. Inventory of Potential Natural Areas on
State Lands: Part 5. A report to the Natural Area
Preserves Advisory Committee to the State Land Board.
141 pp.

Hall, M.J. 1976. Preliminary Inventory and Analysis:
Santiam Bar Proposed Natural Area Preserve. The Natural
Area Preserves Advisory Committee, Oregon State Land
Board. 93 pp.

Starr, R., R. Marston, and M. Hall. 1976. Environmental
Sensitivity of Oregon's Coastal Sand Areas. Department
of Geography, Oregon State University, Corvallis, Resource
Paper Number 7. 38 pp.

Presentations:

Hall, M.J. 1979. Oregon statewide landuse inventory.
Presented at the Western Regional Remote Sensing Conference;
October, 1979; Monterey, California.

Isaacson, Dennis L.

Born: 5 May 1942

Degrees: B.S., 1969, Portland State University, Oregon
M.S., 1972, Oregon State University, Corvallis
M.Ag., 1974, Oregon State University, Corvallis

Positions: Research Assistant, Department of Entomology, Oregon State University, Corvallis, 1970-1974;
Weed Control Supervisor, Oregon Department of Agriculture, Salem, Oregon, 1974-1978;
Research Assistant, Environmental Remote Sensing Applications Laboratory, Corvallis, 1978-present.

Professional Field: Population Biology, Herbivore-Plant Interactions, Vegetation Management.

Professional Recognition: American Registry of Professional Entomologists, Western Society of Weed Science, Entomological Society of America, International Congress of Entomology, International Organization for Biological Control, NSF Undergraduate Fellow-1968, NSF Graduate Fellow-1970-1972.

Selected Publications:

Isaacson, D.L. 1973a. Population dynamics of the cinnabar moth, Tyria jacobaeae (Lepidoptera: Arctiidae). M.S. Thesis, Oregon State University, 65 pp.

Isaacson, D.L. 1973b. Economic losses to tansy ragwort. Proceedings of the 23rd Oregon Weed Conference, pp. 1-3; October, 1974; Portland, Oregon.

Isaacson, D.L. 1977. Federal government participation in Western states' noxious weed control programs. Proceedings of the Western Society of Weed Science 30: 7-8.

Isaacson, D.L., J.K. Kearney, and H.G. Larew. 1978. The biology, distribution and control of new grass species Nardus stricta L. In: Proceedings of the Western Society of Weed Science 31: 151-154.

Isaacson, D.L., R.D. Crenshaw and B.J. Schrumpf. 1978. Inventory of the distribution and abundance of Tansy Ragwort in Western Oregon. Final Report. ERSAL, Oregon State University, Corvallis. 52 pp.

Isaacson, D.L. and B.J. Schrumpf. 1979. Distribution of Tansy Ragwort in Western Oregon. Proceedings of the Symposium on Pyrrolizidine Alkaloids: Toxicity, Metabolism and Poisonous Plant Control Measures, pp. 163-164. Oregon State University Nutrition Research Institute.

Isaacson, D., C. Alexander, B. Schrumpf and R. Murray. 1979. Analysis of association of Landsat spectral classes with ground cover classes in wildland inventories. In press in: Proceedings of the International Union of Forest Research Organizations. Moscow, Idaho, Sept. 21, 1979.

Papers Presented:

Crenshaw, R.D. and D.L. Isaacson. 1977. Remote sensing survey of tansy ragwort in Western Oregon. Paper presented at Society for Range Management; February, 1977; Portland, Oregon.

Isaacson, D.L. 1976b. Use of computer-processed satellite data in an integrated weed control program. Paper presented at International Congress of Entomology; August, 1976; Washington, D.C.

Isaacson, D.L. 1979. Landsat remote sensing applications in the Pacific Northwest. Symposium on Geoprocessing in Oregon. Portland State University, Sept. 21, 1979.

Isaacson, D.L. 1979. Use of large-scale aerial photography in Landsat applications projects. Annual Meeting of Columbia River Region of American Society of Photogrammetry. Portland, Oregon, Nov. 17, 1979.

Appendix
Resume

Lewis, Anthony J.

Born: 12 January 1941

Degrees: B.S., 1962, West Chester State College, Pennsylvania
M.S., 1968, Oregon State University, Corvallis
Ph.D., 1971, University of Kansas, Lawrence

Positions: Research Assistant, Scott Paper Research Lab, Philadelphia, PA, 1961;
Science Teacher, Sparrows Point Jr.-Sr. High School, Sparrows Point, MD, 1962-1963;
Research Assistant, Oregon State University, Corvallis, 1963-1964;
Instructor, Geography Department, Oregon State University, Corvallis, 1964-1965;
Teaching Assistant, University of Kansas, Lawrence, 1966-1967;
Research Assistant, University of Kansas, Lawrence, 1965-1969;
Assistant Professor, Geography Department, Louisiana State University, Baton Rouge, 1969-1974;
Associate Professor, Geography Department, Louisiana State University, Baton Rouge, 1974-1978;
National Science Foundation Fellow and Sabbatical Leave, Department of Scientific and Industrial Research, New Zealand, 1976-1977;
Visiting Professor, Geography Department, University of California, Santa Barbara, 1978-1979;
Research Associate, Environmental Remote Sensing Applications Laboratory, Oregon State University, Corvallis, 1979-present.

Professional Field: Remote Sensing Applications, Geomorphology, Geoscience Applications of Side-Looking Radar, and Image Interpretation.

Professional Recognition: Association of American Geographers, American Society of Photogrammetry, Geological Society of America.

Publications:

Lewis, A.J. 1968. Evaluation of Multiple Polarized Radar Imagery for the Detection of Selected Cultural Features: USGS Interagency Report No. 130, 28 pp., 10 figs., plus appendix of 47 tables. (Also CRES Report No. 61-20).

MacDonald, H.C. and A.J. Lewis. 1968. Radar Detection of Estuarine Meanders in Eastern Panama and Northwestern Colombia: Program (abstracts) Geological Soc. Amer. Annual Mtg., Mexico City, pp. 183, paper presented November 1968.

MacDonald, H.C. and A.J. Lewis. 1969. Applications of Radar Imagery in Geologic and Geomorphic Reconnaissance of Tropical Environments: Program Abstracts, Geological Soc. Amer. Sectional Meeting, Lawrence, Kansas, pp. 18-19, paper presented IEEE Geoscience Electronics Symposium, Washington, D.C., April, 1969.

- MacDonald, H.C., N.N. Kirk, L.F. Dellwig, and A.J. Lewis. 1969. The Influence of Radar Look-Direction of the Detection of Selected Geological Features: Proc. 6th Symp. Remote Sensing of Environment, University of Michigan, Ann Arbor, pp. 637-650.
- Lewis, Anthony J., D.S. Simonett, and H.C. MacDonald. 1969. Detection of High Return Linear Cultural Features on Multiple Polarized Radar Imagery: Proc. 6th Symp. Remote Sensing of Environment, University of Michigan, Ann Arbor, pp. 879-893.
- MacDonald, H.C. and A.J. Lewis. 1970. Mapping and Landform Analysis of Coastal Regions with Radar: Program Abstracts, Geological Soc. Amer. South-Central Meeting, pp. 290, April 1970.
- Lewis, A.J. and H.C. MacDonald. 1970. Significance of Estuarine Meanders Identified from Radar Imagery of Eastern Panama and Northwestern Colombia: Modern Geology, Vol. I, pp. 187-196.
- Lewis, A.J. and H.C. MacDonald. 1970. Interpretive and Mosaicking Problems of SLAR Imagery: Remote Sensing of Environment, Vol. 1, pp. 231-236.
- MacDonald, H.C., A.J. Lewis, and R.S. Wing. 1971. Mapping and Landform Analysis of Coastal Regions with Radar: Geological Soc. Amer. Bulletin, Vol. 82, pp. 345-358.
- Lewis, A.J. and W.P. Waite. 1971. Cumulative Frequency Curves of Terrain Slopes from Radar Shadow Frequency: Preprint of Convention Papers, American Soc. of Photogrammetry, Washington, D.C., pp. 228-244, March 1971.
- Lewis, A.J. and H.C. MacDonald. 1971. Radar Geomorphology of Garachine Bay, Panama and the Atrato Delta, Colombia: Program Abstracts Geography Section of S.W. Social Sci. Assoc., Dallas, Texas, March 1971.
- MacDonald, H.C., A.J. Lewis, and W.P. Waite. 1971. Radar Geomorphology in Louisiana Coastal Marsh and Swamp. Georgia Academy of Science Bulletin, Vol. 29, No. 2, April, pp. 129-129, abstract.
- Schwarz, D.E. and A.J. Lewis. 1971. Landform Regionalization Using Radar Imagery: Proceedings of the Assoc. of Am. Geog. Vol. 5, pp. 194.
- Lewis, A.J. and W.P. Waite. 1971. Cumulative Frequency Curves of the Darien Province, Panama: Proceedings of 17th Annual Symposium of Advisory Group for Aerospace Research and Development (AGARD), NATO, Air Force Academy, Colorado Springs, Colorado, pp. 10.1-10.10, June 1971.

- MacDonald, H.C., A.J. Lewis, and W.P. Waite. 1971. Radar Geomorphology in Louisiana Coastal Marsh and Swamp: Proceedings Abstracts, Annual Meetings Georgia Academy of Science, pp. 128-129, April 1971.
- Lewis, A.J. 1971. Radar Remote Sensing for Geoscientist Short Course Notes, Vols. I and II, University of Kansas, Center for Research, Lawrence, Kansas, August 1971 (Revised June 1972).
- Lewis, A.J. 1971. Geomorphic Evaluation of Radar Imagery of Southeastern Panama and Northwestern Colombia, CRES Technical Report 133-18, 164 pp.
- Lewis, A.J. and W.P. Waite. 1972. Relative Relief from Radar Shadows: Methods and Evaluation: Proceedings of Assoc. of Am. Geog., Vol. 4, pp. 65-70.
- Lewis, A.J. 1972. Geomorphic-Geologic Mapping from Remote Sensors, In: An Introductory Reader in Remote Sensing (J.E. Estes and L.W. Senger, editors), University of California, Santa Barbara, pp. IV.1-IV.21.
- Lewis, A.J. and H.C. MacDonald. 1972. Mapping of Mangrove and Perpendicular-Oriented Shell Reefs in Southeastern Panama with Side-Looking Radar: Photogrammetria, Vol. 28, pp. 187-199.
- Lewis, A.J. and W.P. Waite. 1973. Radar Shadow Frequency: Photogrammetric Engineering, Vol. 39, No. 2, pp. 189-196.
- Lewis, A.J., P.B. Larimore, and S.T. Kim. 1973. Computer Mapping of Wet-Land Soils Using Color Infrared Photography: Proceedings of Second Annual Remote Sensing of Earth Resources Conference, Univ. of Tennessee Space Institute, Tullahoma, Tenn., pp. 703-720.
- Lewis, A.J. and H.C. MacDonald. 1973. Radar Geomorphology of Coastal and Wetland Environments: Technical Papers from American Society Photogrammetry 1973 Fall Convention, Disney World, Florida, pp. 992-1003.
- Lewis, A.J. 1973. Evaluation of Multiple-Polarized Radar Imagery for the Detection of Selected Cultural Features, In: The Surveillant Science: Remote Sensing of the Environment, R.K. Holz (ed.) Houghton Mifflin Co., Boston, pp. 297-313. (Updated version of USGS Inter-agency Report No. 130 published in 1968.)
- Lewis, A.J. 1974. Geomorphic-Geologic Mapping from Remote Sensors, In: Remote Sensing: Techniques for Environmental Analysis, J.E. Estes and L.W. Senger (eds.) Hamilton Publishing Co., pp. 105-126. (Updated edition of article that appeared in An Introductory Reader in Remote Sensing, 1972.)

- Kim, S.T., A.J. Lewis and P.E. Schilling. 1974. Optical Film Density Values from Color IR Photography for Wetland Soils Mapping: Technical Papers from American Society of Photogrammetry 1974 Fall Convention, Washington, D.C., pp. 323-331.
- Lewis, A.J. 1975. Remote Sensing of the Atchafalaya Basin: GSA, South Central Section, 9th Annual Meeting, Austin, Texas, March 1975, (Abstract) pp. 184.
- Lewis, A.J. et al. 1975. Applied Remote Sensing of the Lower Atchafalaya Basin Floodway: Proceedings 10th International Symposium on Remote Sensing of Environment, University of Michigan, Ann Arbor, pp. 1319-1328.
- Lewis, A.J. et al. 1975. Active Microwave Remote Sensing of Earth/Land, In: Active Microwave Workshop Report (NASA SP-376), R.E. Matthews (ed.), Scientific and Technical Information Office, NASA, Washington, D.C., 502 pp.
- Lewis, A.J. et al. (Contributing Authors) 1975. Fundamentals of Image Interpretation (Ch. 14), In: Manual of Remote Sensing, Vol. II, Robert Reeves (ed.), American Society of Photogrammetry, Falls Church, Virginia, pp. 869-1006.
- Lewis, A.J. et al. (Contributing Authors) 1975. Terrain and Minerals: Assessment and Evaluation (Ch. 16), In: Manual of Remote Sensing, Vol. II, Robert Reeves (ed.), American Society of Photogrammetry, Falls Church, Virginia, pp. 1007-1352.
- Lewis, A.J. (ed.) 1976. Geoscience Application of Imaging Radar Systems, RSEMS (Remote Sensing of the Electro Magnetic Spectrum) Remote Sensing Committee of the AAG, Vol. 3, No. 3, 152 pp.
- MacDonald, H.C. and A.J. Lewis. 1976. Operation and Characteristics of Imaging Radar, In: Geoscience Applications of Imaging Radar Systems, RSEMS, A.J. Lewis (ed.) Vol. 3, No. 3, pp. 23-45.
- McCoy, R.M. and A.J. Lewis. 1976. Use of Radar in Hydrology and Geomorphology, In: Geoscience Applications of Imaging Radar Systems, RSEMS, A.J. Lewis (ed.), Vol. 3, No. 3, pp. 105-122.
- Beatty, F.D., A.J. Lewis, and G.W. North. 1976. Source List: Remote Sensing Information, 2nd Ed., EROS Applications Assistance Facility, USGS, Bay St. Louis, Mississippi.
- Lewis, A.J. et al. 1976. An Investigation of the Utility of Gulf Coast Salt Domes for the Storage or Disposal of Radioactive Wastes, Report to Office of Waste Isolation, ORNL-Sub-4112-25, Institute for Environmental Studies, Louisiana State University, Baton Rouge, 329 pp.

- Lewis, A.J. et al. 1976. Development of Remote Sensing Technology in New Zealand, In: Third Quarterly Report, Landsat II Investigation Program No. 28230 (Report No. 553), Physics and Engineering Laboratory, Dept. of Scientific and Industrial Research, Lower Hutt, New Zealand, Sept. 1976. (Also DSIR, Remote Sensing Section Report No.: RS 76/10).
- Lewis, A.J. et al. 1977. Development of Remote Sensing Technology in New Zealand, In: Fourth Quarterly Report Landsat II Investigation Programme No. 28230 (Report No. 568), Physics and Engineering Laboratory, Dept. of Scientific and Industrial Research, Lower Hutt, New Zealand, March 1977. (Also DSIR, Remote Sensing Section Report No. RS 77/2).
- Thomas, I.L., A.J. Lewis, and N.P. Ching. 1977. Snowfield Assessment from Landsat, Physics and Engineering Lab Report No. 576, Dept. of Scientific and Industrial Research, Lower Hutt, New Zealand, 27 pp.
- Lewis, A.J. et al. 1977. An Investigation of the Utility of Gulf Coast Salt Domes for the Storage or Disposal of Radioactive Wastes, Report to Office of Waste Isolation, OWI-Sub-4112-37, Institute for Environmental Studies, Louisiana State University, Baton Rouge, 475 pp.
- Lewis, A.J. 1977. Coastal Mapping with Radar, In: H.J. Walker (ed.) Research Techniques in Coastal Environments, Geoscience and Man, Vol. 18, Louisiana State University, Baton Rouge, pp. 239-247.
- McDonnell, M.J. and A.J. Lewis. 1978. Ship Detection from LANDSAT, Photogrammetric Engineering and Remote Sensing, Vol. 44, No. 3, pp. 297-301.
- Thomas, I.L., A.J. Lewis, and N.P. Ching. 1978. Snowfield Assessment from Landsat, Photogrammetric Engineering and Remote Sensing, Vol. 44, No. 4, pp. 493-502.
- Child, R.C., P.J. Ellis, and A.J. Lewis. 1978. Remote Sensing and Satellite Surveying in New Zealand, Proceedings of Microwave Remote Sensing Symposium, NASA, Houston, Texas, December 1977, pp. 262-266.
- Lewis, A.J. et al. 1978. An Investigation of the Utility of Gulf Coast Salt Domes for the Storage or Disposal of Radioactive Wastes, Vol. 2, Report to U.S. Dept. of Energy, Office of Waste Isolation, EW-78-C-05-5941/53, Institute of Environmental Studies, Louisiana State University, Baton Rouge, 310 pp.
- Lewis, A.J. 1979. Geomorphic Analysis with Side-Looking Radar, In: J.E. Lewis (ed.) Application of Remote Sensing in the Physical Environment, McGill University Climatological Research Series No. 12, Montreal, pp. 39-52.

Lewis, A.J. et al. 1979. Analysis of Seasat-A SAR Data for the Detection of Oil on the Ocean Surface, Final Report USGS Grant No. 14-08-0001-G-560, Geography Remote Sensing Unit, University of California, Santa Barbara, 94 pp. and 5 appendices.

Lewis, A.J. 1979. Remote Sensing of Natural Resources, In: R.W. Fairbridge and C.W. Finkl, Jr. (eds.) Encyclopedia of Natural Resources and Environmental Conservation, (in press).

Lewis, A.J. 1979. Remote Sensing of Coastal Zones, In: M.L. Schwartz (ed.) Encyclopedia of Beaches and Coastal Environments (in press).

Lewis, A.J. 1979. Linear Shell Reefs, In: M.L. Schwartz (ed.) Encyclopedia of Beaches and Coastal Environments (in press).

Internal Papers:

Dellwig, L.F., A.J. Lewis, and H.C. MacDonald. 1968. Edit. Geoscience Overlays for Darien Province, Panama: University of Kansas, CRES Tech. Memo No. 152-1 (Lawrence, Kansas), 22 pp.

MacDonald, H.C. and A.J. Lewis. 1969. Terrain Analysis with Radar -- A Preliminary Study: Interim Tech. Progress Report, Fourth Semi-Annual Technical Report, Project THEMIS, October 1969, pp. F1-F12.

Lewis, A.J. 1970. Relative Relief and Slope Measurements from Radar Imagery: University of Kansas, CRES Tech. Memo No. 133-16 (Lawrence, Kansas), 60 pp.

Lewis, A.J. and F.R. Cavell, Jr. 1971. Problems and Anomalies in SLAR Imagery of the Mississippi-Atchafalaya Deltaic Plain: Final Report, Contract Number NASA 9-11605, 5 pp.

Lewis, A.J. 1971. Map and Remote Sensing Coverage of Louisiana (Appendix B): Final Report Contract Number NASA 9-11605, 20 pp.

Lewis, A.J. and others. 1973. Wetlands Project: A Study of The Resource Base of the Lower Atchafalaya Basin: Final Report Wetlands Project, Joint Legislative Committee on Environmental Quality, State of Louisiana, LSU School of Geoscience, 31 pp., 5 foldout maps.

Lewis, A.J. 1975. Textbooks and References for Remote Sensing, Air Photo Interpretation, Photogrammetry, and Photography, Department of Geography and Anthropology, Louisiana State University, Baton Rouge, 6 pp.

Lewis, A.J. et al. 1975. Inventory, Analysis, and Utilization of Post-Camille Photography, 1969: Final Report for Joint Legislative Committee on Environmental Quality, State of Louisiana.

Invited Lecturer:

Short Course in Radar Remote Sensing for Geoscientists, University of Kansas, Center for Research, Lawrence, Kansas, July-August 1971. (2nd Course also - June 1972).

Remote Sensing Workshop, 22nd International Geographical Congress, Montreal, Quebec, August 1972.

Special Session on Courses and Curriculum in Remote Sensing, 71st Annual Meeting of Association of American Geographers, Milwaukee, Wisconsin, April 1975.

Symposium on Research Techniques in Coastal Environments, Inaugural Symposium in the R.J. Russell Lectureship Series, Louisiana State University, Baton Rouge, March 1976.

Special Workshop on Geoscience Applications of Multispectral and Microwave Sensors, Department of Geography, McGill University, Montreal, Quebec, May 1976.

Forest Industry Advanced Remote Sensing Workshop, USGS/EROS Applications Assistance Facility, National Space Technology Lab, Bay St. Louis, Mississippi, September 1977.

Microwave Remote Sensing Symposium, NASA, Houston, Texas, December 1977.

Advanced Remote Sensing Workshop, Assoc. of Am. Geog., New Orleans, April 1978.

Murray, RJay

Born: 30 June 1930

Degrees: B.S., 1957, University of Utah, Salt Lake City
M.S., 1966, Auburn University, Alabama

Positions: Research Chemist, Shell Oil Company, 1957-1962;
Research Chemist, Thiokol Chemical Corporation, 1962;
Graduate Research Assistant, Computer Center, Auburn
University, Alabama, 1963 - 1966;
Research Associate, Computer Center, Oregon State
University, 1966 - present.

Professional Field: Computer Science, Numerical Analysis, Physical and
Organic Chemistry, Rheology of Polymers, Remote Sensing.

Professional Recognition: American Chemical Society; Association for
Computing Machinery.

Selected Publications:

Simonson, G.H., RJay Murray, et al. 1974. The comparative
evaluation of ERTS-1 imagery for resource inventory in
land use planning. A multidiscipline research investigation.
Final report to NASA Goddard Space Flight Center, Green-
belt, Maryland. Conducted at Oregon State University,
Corvallis, Oregon. July, 1972 - Jan, 1974. 311 pp.

Simonson, G.H., RJay Murray, et al. 1973. Natural Resource
Inventory and Monitoring in Oregon with ERTS Imagery. IN:
Symposium on significant results obtained from ERTS-1,
Goddard Space Flight Center, New Carrollton, Maryland.
March 5-9, 1973. pp. 1451-1458.

Kosolapoff, G.M., and RJay Murray. 1966. Synthesis of some
phosphorous-containing polyimides. Presented at IUPAC
International Symposium on Macromolecular Chemistry,
Kyoto-Tokyo, Japan. 28 Sep - 4 Oct, 1966. (Master's Thesis).

Kruse, R.B., and RJay Murray. 1963. Comment on "Stresses
and Strains in Solid Propellants During Storage". AIAA, 1.
pp. 246-247.

Isaacson, D., C. Alexander, B. Schrumph and R. Murray. 1979.
Analysis of association of Landsat spectral classes with
ground cover classes in wildland inventories. In press
in: Proceedings of the International Union of Forest
Research Organizations. Moscow, Idaho, Sept. 21, 1979.

Schrumpf, Barry J.

Born: 13 July 1943

Degrees: B.A., 1966, Willamette University, Oregon
M.S., 1968, Oregon State University, Corvallis
Ph.D., 1975, Oregon State University, Corvallis

Positions: Graduate Research Assistant, Range Management Program,
Oregon State University, 1966-1970;
Research Assistant, Rangeland Resources Program, Oregon
State University, 1970-1973;
Principal Investigator, NASA Funded ERTS-1 Project, Oregon
State University, 1972-1975;
Acting Director, Environmental Remote Sensing Applications
Laboratory, Oregon State University, 1974-1975;
Director, Environmental Remote Sensing Applications
Laboratory, Oregon State University, 1975-present.

Professional Field: Range Ecology, Remote Sensing, Resource Inventory
and Analysis.

Professional Recognition: Society for Range Management, American Society
of Photogrammetry.

Selected Publications:

Isaacson, D.L., R.D. Crenshaw and B.J. Schrumpf. 1978.
Inventory of the distribution and abundance of Tansy
Ragwort in Western Oregon. Final Report. ERSAL, Oregon
State University, Corvallis. 52 pp.

Schrumpf, B.J. 1975. Multiseasonal - multispectral remote
sensing of phenological change for natural vegetation
inventory. Ph.D. Thesis (Rangeland Resources), Oregon
State University, Corvallis. 213 pp.

Johnson, J.R., B.J. Schrumpf, D.A. Mouat, and W.T. Pyott.
1974. Inventory and Monitoring of Natural Vegetation
and Related Resources in an Arid Environment. Final
Report. Rangeland Resources Program, Oregon State
University, Corvallis. 328 pp.

Schacht, D.W. and B.J. Schrumpf. 1974. The Environmental
Remote Sensing Applications Laboratory, Oregon State
University. Information Bulletin of the Western
Association of Map Libraries. Vol.5, No.3, pp.20-25.

Schrumpf, Barry J., James R. Johnson, and David A. Mouat. 1973.
Inventory and monitoring of natural vegetation and related
resources in an arid environment. Type II Progress Report
No. 2. Rangeland Resources Program, Oregon State University,
Corvallis.

Selected Publications:

Schrumpf, Barry J., James R. Johnson, and David A. Mouat.
1973. Inventory and monitoring of natural vegetation
and related resources in an arid environment. Type II
Progress Report No. 1. Rangeland Resources Program,
Oregon State University, Corvallis.

Poulton, C.E., B.J. Schrumpf, and E. Garcia-Moya. 1972.
A preliminary vegetational resource inventory and
symbolic legend system for the Tucson, Willcox-Ft.
Huachuca triange of Arizona. In: Colwell, R.N. (ed.)
1972. Monitoring earth resources from aircraft and
spacecraft. Chapter V., pp. 93-110.

Presented Papers:

"Project Planning". In: Air and Space Technology in the
Forest Environment. Humboldt State University. Cali-
fornia. August 19-24, 1979.

"Technology Transfer as a Personalized Process." In:
Western Regional Remote Sensing Conference, Panel on
"Technology Transfer: Theory and Practice. Naval Post-
graduate School, Monterey, California. October 17-19, 1979.

Smith, H. Gregory

Born: 12 September 1954

Degrees: B.S., 1976, Oregon State University
M.A., 1978, University of California, Berkeley

Positions: Research Assistant, Remote Sensing Research Program,
University of California, Berkeley, California, Jan. 1977-
June 1978; Research Geographer, Remote Sensing Research
Program, University of California, Berkeley, California,
July 1978 - August 1979; Research Assistant, Environmental
Remote Sensing Applications Laboratory, Corvallis, Oregon,
Sept. 1979 - present.

Professional Field: Remote Sensing, Digital Terrain Analysis, Applied
Statistics.

Papers Presented:

"A Remote Sensing Approach to Land Surface Classification",
Master's Thesis, Department of Geography, University of
California, Berkeley, June 1978, 79 pp.

"Topographic Analysis of a Wildland Area Based on Digital
Terrain Data" by Siamak Khorram and H. Gregory Smith.

-Presented at the American Society of Photogrammetry/
American Congress on Surveying and Mapping Annual
Convention, March 18-24, 1979, Washington, D.C.

-Published in the ASP/ACSM 1979 Annual Convention
Proceedings.

-Published in the book: Case Studies of Applied Advanced
Data Collection and Management, prepared by the American
Society of Civil Engineers Task Committee on Advanced
Data Collection and Management Applications, 1979.

"Site-Specific Mapping of Surface Temperature Based on NOAA-5
Satellite VHRR Data" by Siamak Khorram and H. Gregory Smith.

-Presented at the Eighth Annual University of Tennessee
Space Institute Conference on Remote Sensing of Earth
Resources.

-Published in the Conference Proceedings.

"Spatially-Referenced Mapping of Surface Temperature Based on
Remotely Sensed Data" by Siamak Khorram and H. Gregory Smith.

-Published in the book: Case Studies of Applied Advanced
Data Collection and Management, prepared by the American
Society of Civil Engineers Task Committee on Advanced Data
Collection and Management Applications, 1979.

Smith, H. Gregory, continued

Papers Presented:

"Use of Landsat and Environmental Satellite Data in Evapotranspiration Estimation for a Wildland Area" by Siamak Khorram and H. Gregory Smith.

-Presented at the Thirteenth International Symposium on Remote Sensing of Environment, Ann Arbor, Michigan, April 23-27, 1979.

"An Integrated Study of Earth Resources In the State of California Using Remote Sensing Techniques", H. Gregory Smith-Project Scientist.

-Series of Procedural Manuals:

- 1 - Remote Sensing as an Aid in Watershed-Wide Estimation of Solar and Net Radiation
- 2 - Remote Sensing as an Aid in Watershed-Wide Estimation of Water Loss to the Atmosphere
- 3 - A Remote Sensing Approach to Land Surface Differentiation-Independent Study